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JUNE 18, 1937

# Railway Age

DAILY EDITION

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**W.H. MINER, INC. CHICAGO**

# Railway Age

DAILY EDITION

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## A Job Well Done

The quotation "... Creative research for railroad industry is the job of those who sell them equipment and materials," quoted by W. H. Winterrowd in his paper "Research and Steam Locomotive Development," brings to mind how well the manufacturers of railway equipment have shouldered this responsibility. One needs no further evidence of this fact than a visit to the various exhibits wherein are displayed the results of such research made to the end that service life of equipment and revenue may be increased, and maintenance expenses reduced.

With the railroads now operating approximately 800,000 freight cars more than 20 years old, 300,000 cars more than 16 years old, 450,000 more than 11 years old, and 300,000 more than six years old, the mechanical man cannot help but be impressed with exhibits pertinent to car construction which reveal the savings possible through the use of high-tensile steels, improved

truck designs, welding and the many advances in details, in special types of construction, and in appurtenances. Improved designs of locomotive appurtenances and developments affecting the basic operation of the steam locomotive are being shown which are bound to wield a tremendous influence on the future effectiveness of this type of motive power.

The advances made in machine tools for the railroad shop definitely increase production rates and improve the quality of finished work, thereby directly decreasing maintenance costs during shopping of equipment and indirectly accomplishing this purpose by increasing the service life of locomotives and cars and their appurtenances between shoppings.

All these facts relate to equipment and facilities developed and improved in recent years through the aid of modern engineering science which are improving operating efficiency. The equipment on display this year certainly leaves no doubt that the manufacturers in this field are keeping pace in creative research with those in the most advanced industries of the nation.

## How about John Lewis?

John L. Lewis is not at the conventions, but he is on the minds of many here as well as elsewhere who are wondering what success he will have in his efforts to organize all the unorganized labor in industry and what will be the effect on business. Even the highly unionized railways are troubled because their managements are being warned that, unless they make settlements of the pending wage controversies satisfactory to the members of the standard railway labor organizations, many of their members will go radical and join Lewis' Committee for Industrial Organization.

The history of labor movements in this country indicates that ere long business will be grateful to John Lewis. His movement is definitely radical and intended to subject business, large and small, to radical government and labor policies for the supposed benefit of labor, especially unskilled labor. It is using force to gain its objectives and advertising its use in the evident belief that it can scare business and the general public into submission. In large industrial centers it is being backed by both government action and inaction.

But the public sentiment that will settle the issues raised is not that of large industrial centers. The politics that ultimately control our federal government and most of our state governments is still made in small cities and towns and on the farms. Unless past experience is no criterion the people in small cities and towns and on the farms are going rapidly to get very tired of Mr. Lewis, his Committee for Industrial Organization, and their methods of threat and coercion. The people of Monroe, Mich., did not receive kindly the announcement of a proposed raid of pickets from Detroit, Pontiac and other communities to prevent men from going to work in the Republic Steel Corporation

plant at Monroe, and organized a vigilantes committee to meet force with force.

The people outside cities know and have real influence with their congressmen and senators, and it is significant that numerous statesmen from rural states and communities are beginning to raise their voices in Washington in question as to why Mr. Lewis and his representatives are being allowed to censor the mails, interfere with interstate commerce and do other things forbidden to other citizens, and as to what conditions are being allowed to exist which a high official of the postoffice department says make it "unsafe" for mail carriers to deliver mail at certain places.

If you want to beat a policy, get its exponents to so conduct themselves as to make it odious. The British trade unions called a general strike in 1926 and thereby succeeded in making the British public so mad that the next year Parliament passed the British Industrial Disputes Act imposing severe restrictions on labor union activities, political as well as industrial. This paper no longer regards John Lewis as a menace, excepting temporarily. We think he is going to prove a public benefactor—because if he and his gang follow their present course long they and their political and other supporters are likely to make radical policies as popular as a Republican candidate was last fall. Public sentiment can change quickly in the United States, and Mr. Lewis seems to have been born to change it.

## Intensive Locomotive Development in France

The striking results in steam-locomotive development accomplished by the railroads of France, which are mentioned in a brief interview by Pierre Lavarde, managing director, Société d'Exploitation des Procédés Dabeg of Paris, in this issue, are worthy of serious study by those interested in the development of the steam locomotive in this country. The rebuilt locomotives which he mentioned have shown remarkable horsepower capacity in relation to their boiler heating surface and weight. One of the Paris-Orleans locomotives, with 2,160 sq. ft. evaporating heating surface and 872 sq. ft. of superheating surface, or a combined heating surface of 3,032 sq. ft., has developed an indicated horsepower at high speed of 3,200. This is an indicated horsepower from slightly less than 1 sq. ft. of combined heating surface. Another locomotive of approximately the same size has developed an indicated maximum horsepower of approximately 4,000 at 87 m.p.h., which represents an indicated horsepower for each 0.75 sq. ft. of heating surface. The weights per horsepower of these two classes of locomotives are, respectively, 71 lb. and 60 lb.

There are few locomotives in America which have actually developed an indicated horsepower for less than 1.75 sq. ft. of combined heating surface and none

for which data are available has exceeded one indicated horsepower for 1.5 sq. ft. of combined heating surface. Very few American locomotives have developed an indicated horsepower for less than 100 lb. total engine weight.

## Refining the Steam Locomotive

Since the 1930 conventions and exhibit, when the attention of railway men was generally attracted to the possibilities of roller-bearing installations on driving journals by the presence of the Timken locomotive on the track exhibit, this locomotive and at least one other with a complete installation of driving-axle roller bearings have now served a half-million-miles without the necessity of renewal of any parts of the journal bearings. This service has more than proved the economic value of roller bearings for driving journals.

The next step, anticipated in 1930 as a possibility in the future, is the development of roller bearings for crank-pin journals. This development has now taken place and, although it must still be considered in the experimental stage, offers great promise. As in the case of the roller-bearing development, for driving journals, the necessity of protecting the roller bearings from shocks by close tolerances in the entire chain of moving parts and the possibilities for reducing stresses by the use of better and stronger materials has played an important part in the results to be accomplished with the roller-bearing rods. The improvement in dynamic augment which thus follows as a byproduct is an important contribution to the further development of the steam locomotive to fit it into the new era of high passenger-train speeds.

## "Iron Ships and Wooden Men"

A through train which leaves a large city shortly after 5:00 p. m. recently started out with one air-conditioned coach. It makes several stops within the first fifty miles and local commuters frequently take advantage of its convenient leaving time. On this particular day the weather was hot and sticky and all the commuters boarded the cool and comfortable car, crowding it to more than its seating capacity. The conductor looked upon this as an imposition. It is probable that the scattering of through passengers felt the same way about it, but the circumstances would scarcely seem to warrant the action the conductor took. He turned off the air conditioning and in a short time the crowded car with all its windows closed, fairly steamed. It drove the commuters out—most of them got off when they came to their own station—but it

is hardly likely that the conductor's action helped his railroad from a traffic and public relations standpoint. Air conditioning has given the railroads a great boost, but there are still spots where its application can be improved upon.

## Caution Signals

When one has had an opportunity to look over the exhibits, both on the track and in the Auditorium, and get a general picture of the equipment and accessories that have been developed during the past seven years the impression takes form rather rapidly of the amazing changes that have taken place in the design of locomotives, as well as in their use. In the case of the steam locomotive progress in design has involved the introduction of many new materials and many new processes of manufacture which have combined to increase the capacity and efficiency of modern units. The Diesel has taken its places in the transportation picture and with it has come a new form of prime mover and many new mechanical and electrical accessories.

The increase in passenger and freight traffic in the past two years should leave no doubt that the operating departments of our railroads know how to use the tools that the engineer has given them.

But, behind the scenes in railroading is a group of men upon whose judgment and continuous effort depend the successful utilization of this modern equipment—the men responsible for the maintenance of equipment. All of this development in equipment and accessories which is spread out before us here involves new problems for the maintenance department and the question arises as to how well prepared and equipped that department may be to handle them.

Logically, during the depression the major portion of the expenditures made by the mechanical departments went into motive power and rolling stock with a revival in expenditures for machine tools and shop equipment only during recent months. Yet we know that the modernization of shops and engine terminals has not, by any means, kept pace with the development in equipment.

The high speeds and the heavy loads of today's traffic are imposing on the back shop and the enginehouse the job of meeting the demand for greater accuracy of finish and assembly with shop facilities that are, in all too many cases, sadly inadequate. If the newer equipment which the roads are buying and using to handle today's trains is to be kept in revenue service at a cost that will assure profitable operation the time has arrived when the most serious consideration must be given to an appraisal of repair facilities with a view to the demands of the immediate future. It would be disappointing and tremendously expensive to discover too late that a failure to heed a caution signal that is plainly visible right now should result in expensive failures or mounting repair costs.

## The Programs for Today

The Mechanical Division of the A.A.R. and the Air Brake Association will hold meetings today.

### Mechanical Division

The Mechanical Division will meet in Room B, at the right of the stage in the main exhibit hall of the Auditorium. The meeting will be called to order at 9:30 a.m., daylight saving time, and is scheduled to adjourn at 12:30 p.m. The program follows:

Discussion of Reports on:

Electric Rolling Stock.

Specifications for Materials.

Joint Committee on Utilization of Locomotives and Conservation of Fuel.

Safety Appliances.

Air Conditioning and Equipment Lighting.

### Air Brake Association

Two sessions of the Air Brake Association will be held at Haddon Hall today.

10:00 A. M.—No. 8 ET Locomotive Brake Equipment.

Terminal Testing and Inspection of No. 8 ET Equipment.

2:00 P. M.—New Standard Type AB Freight-Car Brake.

Type AB Empty and Load Brake Equipment.

### Entertainment

10:30 A. M.—Organ Recital, Ball Room; William H. Jackson, Feature Pipe Organist.

2:00 P. M.—Organ Recital, Ball Room; William H. Jackson, Feature Pipe Organist. "A Gala Cotton Fashion Show, presented by The Cotton-Textile Institute, under the direction of Catherine Eloise Cleveland."

9:00 P. M.—Aarrsma Frolic, Ball Room. Cotillion, under personal direction of H. T. McConnell. Johnny Johnson (at the piano) and His Orchestra. Special Entertainment, Nevco Amusement Enterprises, Inc.

## Programs for Saturday and Sunday

### Saturday, June 19, 1937

The entire day set aside by Mechanical Division V to view the exhibits.

10:30 A. M.—Organ Recital, Ball Room; William H. Jackson, Feature Pipe Organist.

2:00 P. M.—Screeno, Ball Room; come one, come all—cash prizes.

9:00 P. M.—International Night, Ball Room; informal dancing. Johnny Johnson (at the piano) and His Orchestra. Special Entertainment, Nevco Amusement Enterprises, Inc.

### Sunday, June 20, 1937

9:00 P. M.—A Gala Concert by Dr. Jenó Donath and His Grand Orchestra, with Henry Hotz and His Madrigal Chorus.

## Registration Figures

The following table shows the registration at 4 o'clock yesterday afternoon, as compared to that at the same time for the five previous conventions. In studying them remember that the P. & S. Division meets during the second week this year, rather than the first week as in the previous years.

	1922	1924	1926	1928	1930	1937
Mechanical, Division V.....	478	650	775	680	699	620
Purchases and Stores, Div. VI.	16	17	400	477	356	9
Motor Transport, Div. VIII...	....	....	....	30	57	....
Railroad guests .....	....	....	....	90	368	322
Railroad ladies .....	337	475	650	700	605	345
Supply men .....	1,771	2,115	2,411	2,257	2,088	1,947
Supply ladies .....	384	484	570	544	424	340
Special guests .....	180	305	250	17	133	22
Complimentary .....	....	....	....	242	*	....
Total .....	3,166	4,046	5,056	5,037	4,730	3,605

\* Complimentary registrations included with railroad guests.

## Lost Badges

The following badges have been lost: 6,038—6,040—6,307—6,349, and 6,414. Finders will confer a favor by returning them to the Enrollment Booth.

## R.S.M.A. Annual Meeting

The annual meeting of the Railway Supply Manufacturers' Association will be held in Room B, at the right of the stage in the exhibit hall of the Auditorium, at 2:30 p. m., Saturday. In addition to regular business matters, a president and vice-president will be elected and reports will also be made of the results of the district elections, which will be held earlier in the day.

## Eubank Nominated

Daniel L. Eubank has been nominated for the presidency of the Railway Supply Manufacturers' Association, and N. C. Naylor as the vice-president. The election will be held at the business meeting on Saturday afternoon, at 2:30. The nominating committee, which met at four o'clock yesterday, consisted of the following members of the Executive Committee: F. J. O'Brien, chairman, from the seventh district; V. W. Ellet, first district; C. W. Floyd Coffin, second district; George L. Gordon, third district; Walter C. Sanders, fourth district; N. C. Naylor, fifth district, and Webb G. Krauser, eighth district.

## French Locomotives Exceedingly Efficient

Pierre Lavarde, managing director, Société d'Exploitation des Procédés Dabeg of Paris, is a visitor at the conventions and exhibits this year. Mr. Lavarde finds American locomotives impressive for their size, but does not think that, for intensive development, American steam locomotives have anything on those of France.

He calls attention to two classes of the high-speed locomotives of the Paris-Orleans which are typical of the lines along which the high-speed passenger locomotives recently placed in service in France have been worked out. These locomotives are compound and steam-pipe

and passages have been refined to reduce pressure loss to the minimum. They are fitted with poppet valves. One of these classes carries a boiler pressure of 243 lb. per sq. in., has a grate area of 46 sq. ft., an evaporative heating surface of 2,160 sq. ft., and a superheating surface of 872 sq. ft. The engine weight, loaded, is about 225,000 lb. This locomotive developed 2,500 drawbar horsepower at 74 m.p.h. up a 0.5 per cent grade with a train of 600 tons, corresponding to approximately 3,200 indicated horsepower. The other locomotive class carries 282 lb. boiler pressure, has a slightly smaller grate of 40.5 sq. ft. and an evaporative heating surface of 2,290 sq. ft. and a superheating surface of 722 sq. ft. The total engine weight is about 240,000 lb. This locomotive, formerly a Pacific but changed to a 4-8-0 type in the conversion, developed a maximum cylinder output of 4,000 hp.

Mr. Lavarde says that during this and next year a number of experimental locomotives will be turned out in France which will permit the study of several systems—turbines or individual piston engines for each axle, boilers with 850 lb. pressure, the velox boiler and the Dabeg-Batignolles locomotive which will be driven by a 12-cylinder V-type steam engine located under the front of the boiler and driving directly on a longitudinal shaft from which the power is transmitted to the driving axles, thus completely avoiding the effects of dynamic augment on tracks and bridges.

## District Elections

The district elections for members of the Executive Committee of the Railway Supply Manufacturers' Association will be held in Room A at the left of the stage in the exhibit hall of the Auditorium on Saturday morning, June 19, between the hours of 10 a. m. and 12 noon. Such meetings will be held by the first, second, fourth, fifth and eighth districts. It will be necessary to elect successors to the following members of the Executive Committee: Victor W. Ellet, first district; J. E. Brown, second district, who was appointed to take the place of R. J. Himmelright, deceased; W. E. Wine, fourth district; N. C. Naylor, fifth district; and Webb G. Krauser, eighth district, who was appointed to serve in place of H. T. Armstrong, deceased, until a successor could be elected to serve the remaining year of the term.

## Ambrose Swasey Dead

Dr. Ambrose Swasey died on June 15 at his summer home in Exeter, N. H., the town where he was born 90 years ago. Called a wizard of precision, Dr. Swasey began his long career as an apprentice in the Exeter Machine Works. A fellow apprentice was W. R. Warner, and the two of them were later to form the firm of Warner & Swasey in Cleveland more than half a century ago. The company was to manufacture machine tools solely, but Dr. Swasey's interest in astronomy soon led his mechanical genius into that field, and, in 1888, the firm completed the first telescope to which mechanical principles were applied, which was installed at Lick Observatory. The doctor also designed the giant telescopes for the United States Naval Observatory in Washington and for the Yerkes Observatory of the University of Chicago.

Dr. Swasey was particularly well known for his interest in the field of education and he donated observa-

tories and chapels to several colleges. He was exceedingly generous to civic, welfare and religious causes. His generous contributions made possible the Engineering Foundation, which has carried on such an important and successful work for many years in encouraging research. He was highly regarded throughout the entire engineering and scientific field and among his many responsibilities, was at one time president of the American Society of Mechanical Engineers.

The list of honors awarded to Dr. Swasey in his long and useful life is an imposing one. In addition to being elected president of the Cleveland Chamber of Commerce for the term 1905-1906, he received the French Legion of Honor in 1921, and the John Fritz gold medal from the engineering profession of America in 1924. In 1932 he was awarded the Franklin Institute Gold Medal, and the following year he received the gold medal of the American Society of Mechanical Engineers. In 1934 the asteroid Swaseya was named for him by its discoverer, and, in 1935 he was given the Washington Award. In 1936, shortly before his 90th birthday, Dr. Swasey received the VDI Medal, given by the Society of German Engineers. Last December he was awarded the Hoover Gold Medal; this was founded by Conrad Lauer of Philadelphia and is given to engineers who have made outstanding contributions to humanity outside of their professional work. The first medal was presented to President Hoover in 1930; Dr. Swasey is the only other recipient.

as chairmen of the railway supply group, and the occupant of the chair at present is R. M. McKisson of the American Steel Foundries. The luncheons are entirely informal—nobody is allowed to spoil them with a speech. The attendance varies widely, but those who attend always learn something worth knowing about what is going on. Just in passing it should be said that "Art" Hohmeyer was the most hard-working and effective membership Committee Chairman the Union League Club of Chicago ever had.

## Registration, Association of American Railroads

### Mechanical Division

Abell, H. F., Mech. Eng., M. P., Colton Manor  
Adams, A. C., S. M. P., Nor. Sou., Marlborough Blenheim  
Adams, C. W., M. M., M. C., Haddon Hall  
Ahn, H. D., Asst. Fore., Off. of E. E., Penna., Madison  
Ambrose, D. M., Mach. Shop Fore., B. & O., Madison  
Ambrose, Reg., Asst. Supt. Car Equip., C. N. R., Claridge  
Ambrose, Reg., Asst. Supt. Car Equip., C. N. R., Claridge  
Anderson, R. E., Gen. A. B. Insp., C. & O., Haddon Hall  
Androucetts, J. A., Elec. Engr., C. & N. W., Chelsea  
Angel, C. M., Eng. of Tests, C. & O., Brighton  
Armer, Alan W., M. M., Pa. & Easton, Ritz  
Armstrong, Geo. W., Chelsea  
Armstrong, W. E. F., Dist. Insp., B. & O., Madison  
Atkins, T. T., Road Elect., C. & O., Chelsea  
Baer, Tinou, Con. Eng., China, Jefferson  
Baker, Roy E., G. A. B. Insp., B. & M., Traymore  
Baldinger, F. A., Dist. M. M., B. & O., Madison  
Baldwin, T. C., M. M., N. Y. C. & St. L., Dennis  
Barrie, J. S., Mat. Insp., N. Y. C., Idlewood, Ocean City  
Barry, J. J., Asst. to S. M. P., N. & W., Claridge  
Barton, T. F., S. M. P., C. & O., Traymore  
Bauer, Ferdinand, S. S., N. Y. C., Shelburne  
Bauer, Ferdinand, Supt. Shops, N. Y. C., Shelburne  
Bebout, G. W., Elec. & Shop Eng., C. & O., Chelsea  
Bennett, P. H., Supt. Shops, M. C., Madison  
Bennett, R. G., G. S. M. P., Penna., Haddon Hall  
Berg, K., M. P., P. & L. E., Claridge  
Bidell, V. J., G. M. & Ch. Eng., N. O., Public Belt, Chalfonte  
Bingman, A. C., M. M., N. Y. C., Ambassador  
Bixby, O. M., Asst. Eng., N. Y. C., Runnymede  
Black, R. L., M. M., N. & W., Claridge  
Blackburn, J. B., Asst. to Ch. Mech. Off., C. & O., Haddon Hall  
Blackley, W. R., M. M., A. & N. C., Haddon Hall  
Bloss, E. K., Supvr. Rail Motor Cars, B. & M., Chelsea  
Boardman, G. W., M. M., N. O., Public Belt, Ambassador  
Bodie, Walter W., Adv. Agt., C. R. I. & P., Brighton  
Bohannon, George W., Mech. Eng., D. M. & N., Ambassador  
Bolling, Nathan, A. B. Insp., C. & O., Haddon Hall  
Bond, T. E., V. P., E. J. & E., Ambassador  
Boyle, T. E., Supvr. Track, Pa.-Reading Seashore  
Bradbury, O. H., A. B. Instr., Southern, Haddon Hall  
Brockman, M. R., M. M., Southern, Haddon Hall  
Brody, D. H., R. H. Fore., D. L. & W., Avon  
Brown, E. F., Elect. Supvr., P. & L. E., Chelsea  
Brown, J. M., Supvr. Elect. Equip., L. V., Byron  
Brown, Ralph W., Mech. Insp., Reading, Claridge  
Brown, T. L., M. M., N. & W., Claridge  
Brown, Wiley F., A. B. Inst., Reading, Haddon Hall  
Browne, A. L., Asst. to Pres., Manufacturers Ry., Haddon Hall  
Bruce, W. H., Secy-Treas., A. & W. P., Marlborough  
Brundage, B., Insp. Air Cond., C. & N. W., Shelburne  
Bryant, C. B., Eng. Test., Southern, Haddon Hall  
Buck, E. R., M. M., Penna., Haddon Hall  
Buckbee, E. J., M. M., N. Y. C., Shelburne  
Buckle, W. G., G. F. C. P. R., Haddon Hall  
Buckley, H. J., M. M., B. & O., Haddon Hall  
Buckpitt, F. W., Supt. Loco. Maint., B. & M., Claridge  
Budwell, Leigh, Mech. Eng., R. F. & P., Marlborough  
Budwell, Walter, M. M., N. & W., Claridge  
Burchnell, J. F., G. F., Socony Vacuum Oil Co.  
Burkett, Douglas L., E. E., B. & M.  
Burel, W. C., M. M., West. Allegheny  
Burruss, J. H., A. B. Instr., C. & O., Haddon Hall  
Butler, F. A., S. M. P. & R. S., B. & A., Marlborough  
Call, Dan, Asst. Air Condition Supvr., R. F. & P., Lafayette  
Callahan, P. J., Supr. Elec. Ltg., B. & M., Chelsea  
Calloway, W. B., G. P. T. M., B. & O., Claridge  
Camper, J. J., Asst. Eng., C. & O., Brighton  
Carlson, W. A., Div. M. M., Erie, Shelburne  
Carroll, E., Supvr. of Tools, Southern, Haddon Hall  
Carson, A. R., Supt. Shops, C. N. R., Claridge  
Cartwright, Kenneth, Mech. Eng., N. Y. N. H. & H., Claridge  
Carty, F. J., Mech. Eng., B. & A., Knickerbocker  
Cavin, W. M., A. B. For., A. C. L., Haddon Hall  
Chadwick, J. P., Asst. to V. P., Southern, Chalfonte  
Chamberlin, S. A., S. M. P., L. S. & I., Traymore  
Chapman, E. C., Eng. Tests, A. T. & S. F., Marlborough  
Chidley, J., Supt. of Equip., N. Y. C., Haddon Hall  
Christophersen, S. E., Supvr. of Boiler Insp., N. H., Chelsea  
Christy, Geo. C., Supt. C. D., I. C., Claridge  
Cilliske, A. I., Asst. to Sec., A. A. R., Seaside  
Clark, Edw., M. M., Cornwall, Jefferson  
Clark, F. H., Cons. Eng., Haddon Hall

### Fashion Show

The ladies at the convention will be interested in a fashion show which is to be given on Friday afternoon, as noted elsewhere on the program. A large number of firms have co-operated and the fashion show committee consists of J. E. Brown, chairman of the Entertainment Committee, assisted by Mrs. A. H. Skean, Mrs. J. Logue, Mrs. Hubert Somers, Mrs. Jerome Haas and Mrs. William Wilson. The show will include fashions of yesteryear in Ameritex prints, followed by beach and pool fashions, active and spectator sports, daytime wear, intimate apparel from an 1885 trousseau, modern intimate apparel, review of children's fashions, evening wear, gowns for wedding guests and a bridal party.

### Railway Supply Group of Chicago

Four years ago A. K. Hohmeyer of the Westinghouse Air Brake Company, started something at the Union League Club in Chicago which will be of interest to railway and railway supply men in other parts of the country. As a director and chairman of the membership committee of the Union League Club he organized and became chairman of a railway supply group which met at a weekly luncheon and invited railway men and other supply men as their guests principally to help "Art" carry on his drive to get new members of the club. The supply men and their guests derived so much pleasure and benefit from the luncheon meetings that they have been continued.

Hunter Michaels of the American Locomotive Company, who is now located at Cleveland; W. E. Robinson of W. H. Miner, Inc.; and the late O. H. Mellum of the American Car and Foundry Company, have served

- Clark, Lester A., Off. Reporter, A. A. R., Ambassador  
 Clegg, Wm. H., Ch. Insp. of A. B., C. N. R., Claridge  
 Cole, W. J., R. F. of E. D. L. & W., Seaside  
 Coleman, R. E., Div. Pass. Agt., B. & O., Claridge  
 Colville, A. B., Supt. Shop, G. N., Traymore  
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 Cotton, Wm. A., Mech. Asst., Erie, Chalfonte-Haddon Hall  
 Coult, Charles C., Fuel Supvr., D. L. & W., Chalfonte  
 Coulter, J. W., S. M. P., Alton & Sou., Marlborough  
 Croft, J. M., Supvr. Movement, Penna.  
 Cromwell, O. C., Asst. to S. M. P. & E., B. & O., Dennis  
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 Wink, L. R., Asst. Supt. C. D., C. & N. W., Traymore  
 Winne, Ross R., Supvr. A. B., B. & A., Haddon Hall  
 Wintersteen, John, V. P. & G. M., Cornwall R. R., Jefferson  
 Withrow, L. W., Mech. Asst., C. & O., Ritz-Carlton  
 Wolfe, C. J., S. M. P., W. M., Marlborough  
 Wood, Carl E., Engr. Train Ltg., C. M. S. & P. & P., Chelsea  
 Wood, Geo. H., Supv. A. B., A. T. & S. F., Claridge  
 Woodward, E. L., Western Mech. Ed., Railway Age, Dennis  
 Wright, A. E., Pres. & G. M., Manufacturers Ry., Haddon Hall  
 Wright, A. L., G. F., B. & A., Haddon Hall  
 Wright, Roy V., Managing Ed., Railway Age, Dennis  
 Wyle, Bruce, Mech. Insp., Reading, Haddon Hall  
 Yoerg, Henry, G. S. M. P., G. N., Traymore  
 Zimkowski, Frank, For. Elect., N. H., Chelsea

## Purchases And Stores Division

Clifford, E. A., Gen. P. A., C. & N. W., Claridge  
 Culver, W. R., Supt. Stores, C. & O., Traymore  
 Dent, Frank, C. C. Storekeeper, Cinc. Union Term.  
 Dickinson, T. R., P. A., B. & L. E., Haddon Hall  
 Douglass, C. S., Asst. to P. A., N. & W., Ritz-Carlton  
 Galloway, W. S., Purc. Agt., B. & O., Brighton  
 Jones, W. E., Asst. P. A., Gen. Motors Corp., Haddon Hall  
 Lacy, H. S., P. A., Jacksonville Term., Ambassador  
 Leech, B. E., Storekeeper, B. & L. E., Haddon Hall  
 Lockwood, P. L., Vice Pres., Atlantic Monorail, Ambassador  
 Long, R. D., P. A., C. B. & O., Claridge  
 McClay, E. J., Storekeeper, Reading  
 McClay, Harold A., Store Attendant, P. R. S. L.  
 Mangam, A. L., Asst. Storekeeper, Penna.  
 Morris, Wm. W., Asst. G. P. A., Penna.  
 Scott, G. E., P. A., M. K. T., Traymore  
 Skinner, L. H., G. P. A., Southern, Brighton  
 Young, James, Asst. P. A., Penna.

## Special Guests

Adair, John G., M. E., I. C. C., Ambassador  
 Beitelman, Edwin J., Elect., L. V., Glaslyn-Chatham  
 Brown, George W., Ch. Personnel, Penna.  
 Brown, John B., Asst. Ch. Insp., I. C. C., Ambassador  
 Burk, E. J., Supt. Shop, N. Y. C., Haddon Hall  
 Caio, Emmanuel, A. B. Test., N. Y., N. H. & H., Haddon Hall  
 Chapek, F., Draftsman, N. Y. C.  
 Colvin, Fred H., Ed., American Machinist, Chelsea  
 Cox, W. E., Asst. Supt., Monongahela Conn., Seaside  
 DeGraff, Geo. W., Asst. Supt., C. R. R. of N. J., Mealey  
 Elmes, Clyde C., Project Mgr., A. A. R., Haddon Hall  
 Fisher, C. D., Mach. Insp., Rtd., Penna.  
 Foster, John S., Engineer, W. & L. E., DeVille  
 Gall, H. J., Trav. Eng., Penna.  
 Gazell, Cornelius, Asst. A. B. For., C. of N. J.  
 Gibson, J. A. B., Major, U. S. A., Marlborough  
 Gilbert, J. B., Sr., Gang Fore., Rtd., Penna.  
 Gormley, M. J., Exec. Asst., A. A. R., Claridge  
 Hall, John M., Ch. Bureau Loco. Insp., I. C. C., Chalfonte  
 Hall, W. E., Mgr. Inf. Sec., A. A. R., Traymore  
 Hanson, Harry C., Insp. Loco., I. C. C., Penn-Atlantic  
 Hart, George B., Supt. Shops, S. P., Shelburne  
 Hartley, W. A., Dist. Supt., Pullman  
 Holden, Hale, Jr., Vice Pres., Pullman, Ritz  
 Holder, J. W., Insp. Loco., I. C. C., Dennis  
 Hout, L. B., Gen. For., Penna.  
 Howard, James, Draftsman, B. & L., Ritz-Carlton  
 Kershner, W. P., Mech. Eng., I. C. C., Shelburne  
 LaMere, R. T., Draftsman, N. Y. C.  
 Marchand, John T., Rtd. Atty., I. C. C.  
 McKinley, Samuel C., Clerk, P. R. S. L.  
 Moore, E. H., Mach., Penna., New Clarion  
 Mulrooney, A. J., R. H. F., Penna.  
 Otis, H. A., Eng. Car Equip., C. N. S. & M.  
 Parker, Wm. E., Machinist, Penna.  
 Pelley, J. J., Pres., A. A. R., Traymore  
 Porcher, Samuel, Asst. V. P., Rtd., Penna.  
 Rake, A., Fitters Apprentice, C. N. R., Knickerbocker  
 Robertson, W. F., Ch. Eng., Western Elec. Co., Haddon Hall  
 Roy, N. H., Research Eng., A. A. R., Haddon Hall  
 Schwering, Felix, Dir. German Nat'l RRs.  
 Sharp, Horace, Gang For., P. R. S. L., 217 Sewell Ave.  
 Squire, F. C., Val. Eng., A. A. R., Dennis  
 Stubbs, Charles, R. H. F., Erie, Haddon Hall  
 Swoddey, A. W., Asst. of Vice Pres., Pullman  
 Symes, J. M., V. P., A. A. R., Dennis  
 Taylor, C. W., Insp., A. T. & S. F.  
 Templeton, W. G., G. M., N. C. & St. L., Dennis  
 Trimble, Robt. E., Engr., Rtd., D. & H., Traymore  
 Ward, William Jos., Gang For., Penna., Chelsea  
 Wightman, Frank A., Loco. Insp., Mass. Dept. Pub. Utilities, Haddon Hall  
 Winter, M. H., Special Appr., A. T. & S. F.  
 Wynn, F. S., Vice Pres. (Ret.), Southern, Marlborough-Blenheim



Geo. T. Johnson,  
President

# A. R. E. E. Discusses Things Electrical



F. E. Starkweather,  
Vice-President



J. A. Andreucetti,  
Secretary-Treasurer

Subjects important to mechanical department work included in progress reports

The Association of Railway Electrical Engineers held its semi-annual meeting at the Hotel Chelsea, Atlantic City, N. J., June 17. George T. Johnson, assistant electrical engineer, New York, New Haven & Hartford, and president of the association, called the meeting to order at 9:30 a.m. Five progress reports were received and discussed by the members.

## Illumination

One installation of sodium units installed on a hump yard is reported to give better illumination, especially in fogs, and has proved so satisfactory that further installations are to be made by the road.

The combination of mercury and Mazda units has made an improvement in illumination, giving higher intensities at lower wattage input than the older systems.

A new high visibility light has been developed for highway lighting that may also find use on railroads.

This unit equipped with terraced reflector and 4000 lumen bar filament lamp provides an illumination in which objects a mile ahead can be seen.

The laboratory development of a new light source known as the fluorescent lamp has recently been announced by the Mazda lamp manufacturers. This development is still in too early a stage to predict anything definite as to the characteristics or commercial applications of this new light source. It is a gaseous type lamp but it differs from former types in that most of the light is generated by conversion of ultraviolet radiation to visible light through the medium of a fluorescent material. The arc stream is contained within a tubular bulb similar in appearance to the Mazda Lumiline type lamps.

Approximately white light as well as colored light may be obtained from a lamp of this type. Laboratory data obtained to date indicate the possibility of a 15-watt tube operating at approximately 60 lumens per watt for green light; 30 for white and pink; and 18 for blue.

A light source of this type when finally perfected should possess considerable merit for railway car lighting service. Since the lamp requires alternating current for operation, a means must be provided for the conversion of the direct current now produced on cars. Several ways of accomplishing this have been suggested and are now being investigated. Among these are the motor generator, vibrator and transformer, and a motor driven commutator device.

A new 1000-watt lamp contained in a T-24 bulb has been developed. The bulb volume is only 43 percent that of the 1000-watt, PS-52 bulb lamp. This feature makes possible the design of smaller fixtures to accommodate a 1000-watt lamp than was possible in the past.

The activities as well as the developments in car lighting have progressed rapidly during the past year. Higher levels of illumination are being adopted for new equipment and in a great many cases existing rolling stock is being relighted in keeping with present-day standards. New types of lighting fixtures have been produced which in general permit greater utilization of the light generated by incandescent lamps. These are being installed and tested in new as well as old equipment and it appears quite likely that practical ways and means of providing adequate lighting will be developed shortly.

In spite of the handicap facing the railroad car lighting engineer, higher levels of illumination must be provided since the public is rapidly becoming conscious of the merits of good lighting and obviously will demand it in all classes of transportation equipment.

The report also states that in the future lamps for car lighting purposes will be designed for a wattage center of 30 and 60-volts instead of 32 and 64 volts. This change will improve lighting conditions when cars are standing in stations approximately 50 per cent. The excess voltage delivered by the generator when the car is moving is absorbed by the resistance unit of the lamp regulator device. In most instances, this change will necessitate a readjustment in the setting of the lamp voltage regulator device when the change is made from 32 and 64 to 30- and 60-volt lamps, so that the lamps will operate at rated voltage

when the train is in motion and at approximately the same voltage when standing in stations.

In the past some difficulty has been experienced with the loosening of the lead wire from the center contact of the lamp base of 250-watt, 32-volt headlight lamps. In general this was caused by the use of these lamps in sockets not equipped with suitable grip devices which would prevent the lamp from loosening under vibration. The loosening of the lamp resulted in an arc taking place between the socket contact and the lamp base which caused the soldered connection to melt and open circuit the lamp. This difficulty has been practically eliminated by welding the lead-in wire to the center contact of the lamp base. Some progress has been made during the past year in the adoption of the prefocused type of lamp for road engine service. The majority of the recently built streamliners have been equipped with this feature and one of the larger railroads has recently adopted it as standard for all road engines.

The use of this lamp possesses considerable merit and must be given serious consideration, especially since higher train speeds are coming into use. Although adequate voltage and proper headlight case alignment are required, satisfactory headlighting cannot be had unless the lamp is properly focused in the reflector. Since hand focusing varies with individuals, the prefocused type of lamp appears to offer considerable possibility in the improvement of headlighting in general.

The report also includes tables showing the trend in demand for different types of lamps used in car and locomotive service.

The report is signed by: G. W. Bebout (chairman), electrical and shop engineer, Chesapeake & Ohio; L. S. Billau, assistant electrical engineer, Baltimore & Ohio; G. E. Kirby, electrical supervisor, Boston & Maine; G. L. Sealey, electrical engineer, Reading; G. T. Johnson, assistant electrical engineer, New York, New Haven & Hartford; C. G. Winslow, assistant electrical engineer, Michigan Central; J. E. Gardner, electrical engineer, Chicago, Burlington & Quincy.

G. T. Johnson, assistant electrical engineer, New York, New Haven & Hartford, expressed the desire for information showing the trend in the use of lamps of various wattages designed for different hours of life. H. H. Helmbright, railway lighting, General Electric Company, said this information can be provided in so far as lamp life is concerned. Most roads, he said, are now using the 750-hour lamp, and very few 1000-hour lamps are in railroad service. It would be desirable, he said, to show total costs and thereby determine the advantage of using the more efficient lamp and changing it more often.

J. A. Andreucetti, electrical engineer, Chicago & Northwestern, asked if there were any new information not included in the report concerning fluorescent lamps. To this Mr. Helmbright replied that there was no new information and that the lamps were not yet out of the laboratory. Mr. Andreucetti then asked several questions concerning the use of 30- and 60-watt car lighting lamps. Mr. Helmbright said some roads have for a long time used the 28½-volt country home lamps which have the same advantage as the 30- and 60-volt lamps and both make it possible to provide good lighting when the train is standing as well as when it is in motion. The 30- and 60-volt lamps are designed with a wattage center shifted to the lower voltage so that they give the same light at 30 and 60 volts that they did formerly at 32 and 64. This change, he said, does not appreciably shorten the life of the lamps, since vibration is the factor of greatest importance. Mr. Andreucetti reported a test which is now being run on the Northwestern in which 30-volt lamps are used on one train and 32- on another. The tests have now been in progress for a burning period of 750 hours and there has been a slightly greater loss of the 30- as compared with 32-volt lamps. This, he said, however, is of little consequence as compared with the improvement in lighting.

G. R. Berger, K. W. Battery Company, raised the question of what the effect of lower voltages would be on lamp regulators. G. W. Wall, foreman electrician,

Delaware, Lackawanna & Western, said that his road has always used the lower voltage lamps and that in his experience the loss of lamps is not so much due to voltage as due to handling and work done in cleaning the cars. Carbon disintegration on lamp regulators, he said, has not been noticeable. He added that he is particularly pleased to learn that it is no longer necessary to pay a price differential for the lower voltage lamps.

A. E. Voigt, car-lighting and air-conditioning engineer, Atchison, Topeka & Santa Fe, said that lamp fixture manufacturers were in many instances going back to a practice disapproved of long ago, namely, that of mounting lamps horizontally. There is also, he said, a trend toward the use of small lamps; this being objectionable because of their relatively low efficiency and greater cost due to increased number of lamps required. Mr. Johnson stated that horizontal burning of 115-volt lamps which are under vibration results in decreased life. The tendency toward the use of small lamps was confirmed by Mr. Helmbright, who explained that it was due to a desire for novelty in the forms of fixtures.

R. R. Brady, Westinghouse Lamp Company, spoke briefly on tubular lamps, saying that conduction currents heat the base when the lamp is burned base up and under no circumstances could such lamps be expected to give service equal to the standard type. In reply to a question from Mr. Voigt he said that the tubular lamps do not give equivalent illumination for watt input and that the coiling of the filament in standard lamps makes for higher efficiency.

### Car Electrical Equipment

The work of the committee on car electrical equipment has been sub-divided and assigned to seven sub-committees, as follows:

1. Air-Conditioning Equipment.
2. Axle Drives.
3. Voltage of Lamps.
4. Electric Marker Lamps.
5. Storage Batteries.
6. Revision of Manual.
7. Development of Power Supply Equipment.

(1) A Fulton-Sylphon control has been applied to about 100 air-conditioned cars equipped with ice-activated systems. And it is expected that the completed report will include this application and also a similar one for mechanical compressor systems. Vapor correlative control is being placed in service and the performance of this equipment should determine whether such automatic control is practical and as desirable as is generally thought to be the case. The sub-committee expects to report on the need for exhaust fans and thermostat locations. Plans have also been made for publishing a detailed report of total cars equipped for air conditioning.

(2) The sub-committee on axle drives is following the development of new drives and the performance of those in service. These studies include the Gerlinger drive and the Reeves drive designed by Frigidaire.

(3) The sub-committee on lamp voltage has placed its stamp of approval on the use of 30- and 60-volt car-lighting units; these lamps are now available at no increased cost over the 32- and 64-volt lamps.

(4) Sub-committee No. 4 is preparing a recommendation for a universal plug and receptacle for electric-marker lamps.

(5) The sub-committee on storage batteries is considering a battery box larger than the present standard to better accommodate the higher capacity batteries now being installed. An attempt is also being made to reduce the number of wire sizes used for battery connectors.

(6) Present matter in the A.R.E.E. Manual dealing with car-lighting equipment is being revised and brought up-to-date; some of this is being rewritten.

(7) The committee on development of power supply equipment is preparing a study on the relative economic advantages of the 32-, 64- and 110-volt axle systems. It is planned to sub-

mit estimates of the cost of changing individual cars from present to higher potentials when desirable, and also to develop an estimate of the cost of equipping a train with a power car to supply all auxiliary electric power for a train independent to the locomotive.

The report is signed by G. W. Wall (Chairman), foreman electrician, Delaware, Lackawanna & Western; P. J. Callahan (Vice Chairman), supervisor car & locomotive electric lighting, Boston & Maine; R. E. Gallagher, electrical engineer, Louisville & Nashville; E. S. M. MacNab, car lighting engineer, Canadian Pacific; F. J. Hill, general supervisor car electrical equipment, New York Central; L. J. Verbarg, air-conditioning engineer, Missouri Pacific; F. Zimkowski, electrical supervisor, New York, New Haven & Hartford; A. E. Voigt, car lighting & air-conditioning engineer, Atchison, Topeka & Santa Fe; D. F. Carter, assistant electrical engineer, Chicago, Burlington & Quincy; G. E. Hauss, chief electrician, Cincinnati Union Terminal; S. G. Petersen, shop engineer, Seaboard Air Line; W. T. Kelley, assistant engineer, New York, New Haven & Hartford; L. R. Raether, chief mechanical electrician, Michigan Central; E. H. Burgess, inspector of air-conditioning, New York Central.

Because it involved one phase of the subject covered by the report, Chairman Johnson called attention to an article on rectifiers for car battery charging by W. S. H. Hamilton, equipment electrical engineer, New York Central, published in the June, 1937, issue of *Railway Electrical Engineer*. This development, Mr. Johnson believes, is something which will be of great help to the railroads, and he asked Mr. Hamilton for additional comments concerning the use of rectifiers for car battery charging.

Mr. Hamilton said that motor generator sets were first considered for the charging requirements of cars having large batteries but that rectifiers were adopted because of their small weight, small space requirements and quiet operation. It has been found, he added, that certain cars, notably diners, require much charging and if ordinary means are used, these cars tie up yard charging lines for long periods. The situation, he said, may be handled effectively by using mobile chargers operating from a.c. distribution lines and further improvements may be effected by applying rectifiers on cars which have the greatest needs. Diners and mail cars would in his consideration probably be those most needing on-a-car units. One of the mobile units has been in service in Detroit all winter. Mr. Hamilton had hoped for more rigorous weather in which to test this application, but he said that results indicate that the units are not affected by weathering.

The committee on car electrical equipment has the heaviest assignments of all the association's committees. Mr. Wall requested that members submit suggestions for further work in writing.

G. W. Bebout, electrical and shop engineer, Chesapeake & Ohio, asked men from other roads to describe their experience with correlative control for air conditioning equipment. He was particularly concerned to know if it works well in the spring and fall when sudden changes of temperature are experienced. C. R. Sugg, electrical engineer, Atlantic Coast Line, replied that his road has had such controls in service during the past winter and that their performance in the spring was entirely satisfactory. Correlative control, he said, is better than manual, because crews seem to like to get the cars as cold as possible. The control, he said, is much more uniform and the only complaints come from the train crews. The Coast Line put 16 equipments in service last winter, have applied 15 since, and will apply 18 more. F. Zimkowski electrical supervisor, New York, New Haven & Hartford, said that three had been placed in service on his railroad but that it had been necessary to remove two of them because of unsatisfactory operation. No complaints, he said, had been received from the third unit.

E. S. M. MacNab, car lighting engineer, Canadian Pacific, asked for information on the performance of V-belts in northern country operation. Mr. Zimkowski replied that the trouble with V-belts in most cases has been the fault of the truck; that some of the four-wheel trucks on which they were applied were not satisfactory. Generally, he said, V-belt performance is highly satisfactory if they are given proper inspection and maintenance.

A. E. Voigt, car lighting and air conditioning engineer, Atchison, Topeka & Santa Fe, expressed the opinion that if it were possible to reduce the number of belts and thereby avoid overloaded belts when some were lost their operation could be further improved.

J. A. Andreucetti, electrical engineer, Norfolk & Western, thought when  $\frac{7}{8}$  V-belts are used instead of flat belts for a straight belt drive the usual difficulty is the fastener. Unequal loading of belts, he said, does not cause much trouble and added that belts have greatly improved the continuity and quality of performances and that while they do not effect any economy as compared with the flat belt, the improved service is easily worth the difference in cost. Until the fasteners are improved, he said, the cost of V-belts will be high. His opinion was substantiated by Mr. Zimkowski, who said that endless V-belts are seldom lost.

Mr. Hamilton said that the New York Central has been experimenting with rubber containers instead of wooden battery trays for storage batteries and that reduction of damage is apparently sufficient to justify their use. Direct current plugs and receptacles he said should be interchangeable for the present 100-ampere and 150-ampere charging units. His road is applying the 150-ampere size to all cars having more than a 400-ampere battery. The old equipment, he said, can be continued in use up to its capacity during the period of transition while all plugs will eventually be of the 150-ampere size. He also made a plea for 60-volt car lighting systems as compared with 30-volt. It is not necessary, he contended, to go to 100-volts, since there is no question of voltage drop to lamps at 64-volts and battery requirements are greatly reduced.

### Locomotive Electrical Equipment

The four subjects being considered by the committee on locomotive electrical equipment concern (1) development of standard practices for shop maintenance work on turbine generators and other lighting equipment, (2) pre-focused mounting for headlight lamps, (3) general maintenance and practice of locomotive equipment, including new development, and (4) revision of manual.

The committee is now collecting information concerning tolerances and limits of wear, and when these are in hand, the report on development of standard practices will be complete.

No new information has been sought concerning pre-focused mounting, since this subject has been quite fully covered in previous reports. The completed findings on general maintenance and practice will be concerned with several new developments now being offered by the manufacturers. Each member of the committee has been detailed to go over the locomotive electrical equipment section of the A.R.E.E. Manual and make recommendations for revision.

The report is signed by: L. R. Raether (chairman), chief mechanical electrician, Michigan Central; P. J. Callahan, supervisor car & locomotive electric lighting, Boston & Maine; L. G. Conklin, general electrical inspector, Delaware & Hudson; F. J. Hill, general supervisor car electrical equipment, New York Central; J. W. Johnston, chief inspector car lighting and headlighting equipment, Canadian National; C. W. Nelson, supervisor train control & train lighting, Chesapeake & Ohio; P. E. Starkweather, electrical engineer, Pere Marquette.

G. W. Bebout asked for information concerning a new type of headlight which has been developed for high-

speed trains in which the reflector and lamp oscillate. J. A. Andreucetti, electrical engineer, Chicago & Northwestern, said that such a light is in service on the Northwestern's Four Hundred. He explained that it is really not a headlight but a warning light used in addition to the regular headlight. It has been in service only a short time, but has met with favor. Some difficulty has been experienced with the lamp used and he asked that some manufacturer tell what might be done about it. H. H. Helmbright, railway lighting, General Electric Company, said that the "headlight signal" as it is called involves the first application of a 12-volt 30-ampere lamp to use on a steam locomotive. The first trials were not satisfactory because the base broke away from the lamp but another lamp of the bi-post type is being prepared for this service. Until that lamp is developed means must be provided for relieving the present lamp of vibrations. Some work has been done and one lamp has successfully completed six round trips.

R. G. Gage, electrical engineer, Canadian National, wanted to know how the oscillating motion is given to the lamp and reflector, and Mr. Helmbright said it is moved by a motor-driven device. P. J. Callahan, supervisor, car and locomotive electric lighting, Boston & Maine, concluded the discussion by stating that the committee particularly wanted suggestions concerning shop practice for maintaining turbo-generators.

### Railway Automotive Equipment

The subjects assigned were discussed, and the committee reports as follows:

1. Make an intensive study of essential tools for handling repairs in the most practical and efficient manner.

Mr. Bloss is making a study of this subject for his road and will write up the results of his investigation as additional information.

2. Report on reducing fuel cost (report on Butane).

Since the Diesel is rapidly superseding the gas engine for traction purposes, the committee feels that it would not be justified in working up a report on Butane.

3. Make a study to determine correct size of power unit and gear ratios for gas or oil-electric motor cars and locomotives intended for handling mixed train service over branch or main lines under average operating conditions.

It was the consensus of opinion that this subject was one requiring special investigation for each particular run considered and that anything the committee could do would be so general that it would not be of much value and, therefore, no time should be spent upon it.

4. Make a study of Diesel engines for railway use.

In view of the rapid increase in the use of Diesel engines for motive power the committee feels that this is one of the most important subjects it has to study. It is proposed to write a general specification for oil-electric motive power units which could be used as a basis for a specification by any road.

5. Make a study of various control systems used on rail cars and locomotives.

It was decided that a description of the Allis Chalmers control system and the new G.E. speed control as used on the New Haven switchers, would be added to last year's report as information.

6. Make a study of maintenance organization required to handle automotive equipment in the most efficient manner.

It was the consensus of opinion that last year's report covered this subject and nothing more should be done.

7. Study the class and percentage of passenger service on existing railways that can be economically operated by Diesel power of reasonable size and cost.

The committee feels that this is a problem for each individual road to work out and is largely a question of policy of the Management.

The report was signed by: A. R. Walker (chairman), elec-

trical engineer equipment, Illinois Central; E. Wanamaker, electrical engineer, Chicago, Rock Island & Pacific; E. K. Bloss, supervisor rail motor cars, Boston & Maine; S. C. Morse, rail motor car inspector, New York Central; R. G. Gage, chief electrical engineer, Canadian National; J. E. Kilker, shop engineer, Missouri Pacific; W. F. Freutel, general electrical inspector, Chesapeake & Ohio; E. F. Weber, superintendent automotive equipment, Chicago, Burlington & Quincy.

A. R. Walker, electrical engineer equipment, Illinois Central, who presented the report, said that the committee particularly wants suggestions for specifications covering the construction of oil-electric cars and locomotives. Because of the difficulty of presenting such recommendations from the floor, Chairman Johnson suggested that the members send in their recommendations in written form.

### Motors, Control and Wiring Installation

The two subjects assigned to the committee on motors, control and wiring installation were recommendation for wiring hazardous locations and review of previous A. R. E. E. reports and Manual for additions to the Manual. The report states that National Electric Code rules for hazardous locations should be followed, except where it is necessary to comply with local, city or state regulations.

Hazardous locations on railroads would include:

Acetylene gas generating plants, gasoline handling facilities, paint shops and mixing rooms, waste reclaiming plants, grain elevators, coal handling plants, woodworking plants, warehouses in which are stored combustible fibres such as cotton, excelsior, baled waste or other similar materials.

The committee would classify these facilities as follows:

Acetylene gas generating plants—class 1, group A; gasoline and oil handling facilities, paint shops and mixing rooms, and waste reclaiming plants—class 1, group D; coal handling plants—class 2, group F; grain elevators—class 2, group G; woodworking plants—class 3; warehouses in which are stored combustible fibres, such as cotton, excelsior, baled waste and other similar materials—class 4.

Briefly, the hazards in the four classes of locations are due to the following causes:

Class 1—Highly flammable gases or vapors.

Class 2—Combustible dust.

Class 3 & 4—Combustible fibres and flyings.

The report adds that considerable common sense and good judgment must be exercised in determining whether the location under consideration should be considered as hazardous and, if so, what portion of the premises should be so classed. An entire plant is not necessarily a hazardous location because a hazardous process is carried on in one section of the plant. For illustration, where a small amount of spray painting is being done in one part of a room, the larger portion of the space in the room being used for other purposes. One State Board of Fire Underwriters considers the hazardous condition in such case as extending to a distance of 25 feet from the booth. This is a more or less arbitrary rule, but appears to be reasonable and to work out well in practice.

The committee reports progress on the revision of the Manual and adds that, because no recommendations have been made since 1929, a considerable amount of study and work is required.

The report was signed by: J. A. Cooper (Chairman), assistant electrical engineer, Wabash; C. G. Winslow, assistant electrical engineer, Michigan Central; W. C. Chapman, general electrical inspector, Chicago & North Western; Geo. Dodds, electrical engineer, Delaware & Hudson; A. P. Dunn, electrical foreman, Michigan Central; E. R. Hall, road foreman electrician, Chesapeake & Ohio; E. R. Sayle, electrical foreman, Atchison, Topeka & Santa Fe; F. J. Erb, electrical inspector, Chicago, Burlington & Quincy.

G. T. Johnson, assistant electrical engineer, New York, New Haven & Hartford, called attention to the fact that the report involves more than would appear from a casual reading. It appears, he said, as if the original National Electrical Code included clauses which were unnecessary. He asked if anyone could tell what association is now making a study of static conditions which

might cause explosions of flammable dust and gases. It was his understanding that some committee is now working on this subject and he suggested that contact with this committee might result in a considerable saving to the railroads.

J. A. Andreucetti, electrical engineer, Chicago & Northwestern, explained that the report is designed especially for the benefit of the smaller railroads for which definite recommendations are necessary. The cost of

explosion-proof equipment is high and an accurate determination of its needs is important. It was pointed out by Mr. Johnson that in many locations explosion-proof equipment is used side by side with other devices which cannot be so qualified and that a better understanding of requirements would eliminate such inconsistencies. Particularly, he said, is it necessary to determine if existing installations are adequate and to learn also what kind of testing is desirable.

## Conventionalities . . .

That cosmopolitan air worn with pride by J. H. Davis, chief engineer-electric traction of the Baltimore & Ohio, is the result of a very recent European trip.

Count Charlie House is among the benedicts attending the convention. The debonair superintendent of motive power of the Alton is, in point of fact, here on his honeymoon.

Bill Robertson, vice-president of W. H. Miner, is, we venture to say without fear of contradiction, the only railway supply man who has visited South Africa within the past year.

The best place to settle a hot argument on the exhibit floor is immediately in front of the air-cooling generator, where many a representative is taking a fevered brow to cool.

Alonzo G. Decker, of Black & Decker, is going directly from the convention to Europe, sailing June 23. S. Duncan Black, of the same company, is already there, having sailed on the Queen Mary on May 26.

M. M. Armendariz, sales representative for the General Steel Castings Company, the American Steel Foundries and the American Car & Foundry Company in Mexico City, was a visitor yesterday.

Walter S. Carr, president of the Locomotive Firebox Company, and Mrs. Carr recently returned from Europe. They attended in England the coronation of King George VI, and later traveled in Holland, Denmark, Norway and Sweden.

Perry Shoemaker, superintendent of freight transportation, N. Y. N. H. & H., and said to be the only mechanical engineer in the country in the railway transportation department, was a visitor to the convention yesterday.

By actual count on the part of our statistical expert, 81 delegates failed to find their wives and their tables last night after rides on the merry-go-round bar, between the hours of 11:47 and 12:18.

C. H. Loutrel, president of the National Lock Washer Company, most unwillingly holds the record for short attendance at the convention. Hardly had he arrived here when he was called home by an urgent telegram.

Regardless of the comparative inaccessibility of the exhibits in the basement and out in the hall off the main lobby, delegates will find the extra steps worth their while, as there is much of interest on display there that could not be accommodated in the main hall.

A. N. Williams, president of the Chicago & Western Indiana and the Belt Railway of Chicago, came over from Washington and spent yesterday looking over the exhibits. Mrs. Williams and their daughter, Ruth, are sailing today (Friday) from Montreal for a few weeks in Europe. Mr. Williams will join his daughter, Mollie, in August, at his ranch twelve miles south

of Denver, from whence they will go for a three weeks' vacation and camping trip in the Big Horn country.

### Customers Entertain

G. I. Wright, Manager, transportation department, Westinghouse Electric & Manufacturing Company, recently spent several weeks on the west coast to survey transportation facilities. While in San Francisco he was entertained at luncheon by twelve customers, all of whom had been former associates. Previous to entering the employ of the Westinghouse Company, Mr. Wright was Chairman of the Electrical Section of the A. A. R.

### For the Third Time

In Wednesday morning's *Daily* the Alan Wood Steel Company was classified under "W" in the list of exhibitors. A correction was published in Thursday morning's *Daily* under the head of Additional Exhibitors. In some way the item was changed and was again classified under "W". Mistakes will happen, but let us hope that this time it will be correct. It should be under the "A's"—*Alan Wood Steel Company*.

### The Captain Loves the Sea

Captain William Bell Wait really deserves his title, which is by no means of the Kentucky colonel variety. Before becoming president of the Valve Pilot Corporation, the captain frequently went down to the sea in ships, and was in convoy service during the World War. For a combination business-pleasure trip, he is taking a sort of busman's holiday later this summer, and sailing for England, France and Belgium. All of this, however, is merely incidental to the important business of the day, which is to recommend to all and sundry that, for real interest and information, they ask the captain to explain how one goes about catching lost canaries on Riverside Drive.

### To the Ladies

Mention of Miss O. W. Dennis of the Baltimore & Ohio as the only woman engineer in attendance at the convention in yesterday's *Daily* brought forth several suggestions that we had forgotten Miss Allen of the Association of Manufacturers of Chilled Car Wheels. While we yield to no one in our admiration of Miss Allen and her work in design, we still insist that our original statement was correct, for Miss Allen is an artist and not an engineer.

### Miniature Golf Course Wanted

Braman S. Rockwell, president of the Illinois Railway Equipment Company, is a good golfer, nay, an excellent one. Some three weeks ago, he made a vow that he wouldn't take another drink until he broke 90. For some of us, this would mean a permanent ride on the water wagon, but for Mr. Rockwell, who usually shoots in the low eighties, it seemed a casual enough matter. What happened? Well, since then Braman S. has been shooting the finest collection of 91s and 92s ever assembled on one man's score card, but nary an eighty can he notch. He's still faithful to his vow, but, when last seen yesterday afternoon,

he was engaged in combing Atlantic City in the hopes that there still remained, somewhere within its purlieus, a pee-wee golf course on which he could shoot a snappy 32 or 34 and rid himself of the old man of the sea now fastened about his neck.

### Tenth Floor—Hotel Dennis

Ever eager to make a sale, Marshall D. Raymond, district sales manager of the American Locomotive Company at San Francisco, hurried over night before last on a "hot tip" that stated a big customer was awaiting him on the tenth floor of the Hotel Dennis. Undoubtedly, what with Marshall's sales ability, there would have been a stir in the locomotive sales—except that the Hotel Dennis has only nine floors.

### What's Your Choice, Gentlemen?

Our pari-mutuel operator reports a heavy play as to the number of model trains on display, and as to which one will win the Supply Exhibit Derby in their endless race 'round and 'round. Our own personal favorite is a snappy little green filly downstairs that whirls about the track with a delightful knee action, but there are many other favorites. The betting ranges all the way from 11 to 44 as to the number of model trains on exhibit, but we favor the middle ground of 29 as the total number.

### Central Club Outing

James Singer, master mechanic of the New York Central, and president of the Central Railway Club of Buffalo, reports a recording-breaking attendance at the outing of that club last week. It joined with the Transportation Club of Buffalo in a 50-mile excursion Saturday afternoon, on a See and Bee steamer. The boat left Buffalo at 3:00 p.m. and returned at 9:00 p.m. About 1,400 were in attendance. The Central Railway Club has secured 249 new members since the first of the year, a sure sign of healthy growth, when coupled with the excellent programs it has been scheduling.

### Silver Locomotive

We are indebted to J. W. Motherwell, vice-president and general manager of the Ashton Valve Company, and to M. B. McPartland, general superintendent of motive power of the Chicago, Rock Island & Pacific, for the accompanying illustration of an interesting old-timer in American railway history. This locomotive pulled the Kansas City Night Express of the Rock Island, with six cars, at speeds of over 70 miles an hour. It was built by the Grant Locomotive Works, Paterson, N. J., and the trimmings, handles, whistle, pump, flag staffs, headlight and brackets were covered with pure silver. The locomotive was an 8-wheel American type, 16-in. x 24-in. cylinders, 140 lb. pressure, and 66-in. drivers. Edward C. Kenyon, Pacific Coast representative of the Ashton company, ran this very locomotive for some years in the nineties. Mr. Kenyon, by the way, ran an engine when he

was 18, and was on a passenger run at 21. He comes by his good looks naturally. Doris Kenyon, the beautiful movie star, is his cousin.

### Three Generations

With the arrival at the convention yesterday of F. M. Brazier, a cycle of three generations was completed. He is the son of F. O. Brazier, of the Murphy Varnish Company, and the grandson of the late F. W. Brazier, who was well known at the conventions until his recent death, and was a life member of the association.

### The Press

Several of the metropolitan newspapers and press associations have sent representatives to the convention to report its proceedings and describe the interesting features of the exhibits. Unfortunately, these men are unanimous in declaring that, lacking a press room, getting information as to the convention is as difficult for them as pulling hens' teeth.

### Proof

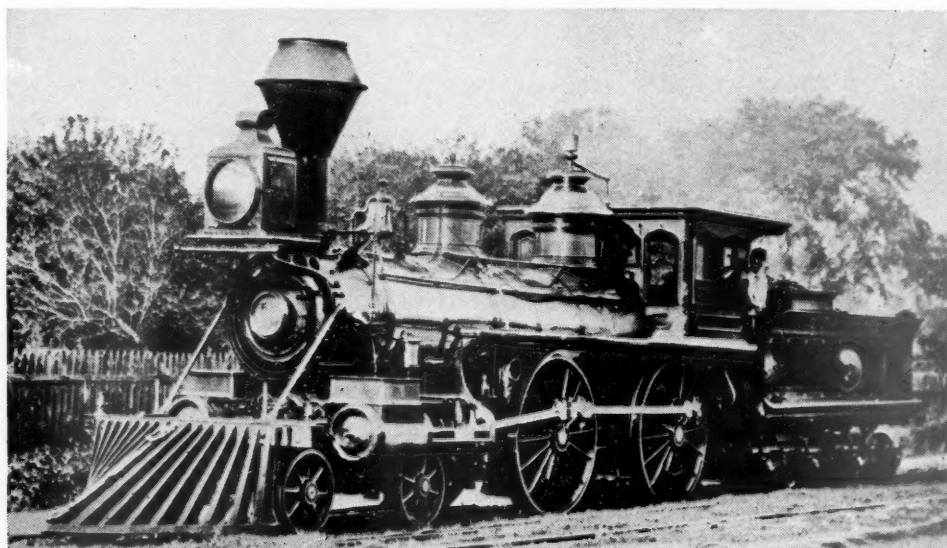
C. P. Diehr, retired master mechanic, with a service record of 48½ years on the New York Central, arrived at the convention yesterday, and presented actual proof that he was in attendance at the convention here in 1907, in the form of the official list of delegates and guests of that convention, with his name duly enrolled therein.

### Non-Coronation Visitor

Of all the Americans who flocked to England for the Coronation, may we recommend, for excellent good sense and sound judgment, H. K. Williams, of the Safety Car Heating & Lighting Company. He was in England on May 12 right enough, but, instead of indulging in the terrible food and worse hotel service of that time, and instead of sitting disconsolately in the rain for ten or eleven hours waiting to see a furtive carriage slip by that might or might not have contained Their Majesties, Mr. Williams remained in beautiful Plymouth on the south coast, basking in sunshine and listening to the Coronation on the radio—beg pardon, the wireless.

### Bully for You, Purdue! Purdue!!!

Among the "cap-and-gowners" present at the convention is H. Rubenkoenig, professor of railway mechanical engineering at the University of Purdue, who, when pressed for information as to the progress of the world and of scientific achievement in Indiana, admitted, without too much hesitation, that the Purdue football team should win all its games next fall by a margin of at least two touchdowns.



# Air Brake Meeting at Haddon Hall



W. H. Clegg, President



R. M. Long, 1st Vice-Pres.



W. F. Peck, 2nd Vice-Pres.



C. H. Rawlings,  
3rd Vice-Pres.



T. L. Burton, Secretary

Opening sessions devoted to discussion of new Type F-1 Lubricator for air compressors, brake-beam-hanger maintenance and the HSC passenger brake

**A**T two sessions held yesterday at Haddon Hall, Atlantic City, N. J., the Air Brake Association reconvened for a two-day business meeting after an interval of seven years since the last previous convention held at Chicago in 1930. A total of 80 representatives of railway, air-brake and supply men were in attendance at the opening meeting, which began at 10 a.m., and 60 at the afternoon session which opened at 2 p.m. The meeting was presided over by President W. H. Clegg, chief inspector air brake and car heating equipment, Canadian National, general arrangements for the meeting having been made by Secretary T. L. Burton, air-brake engineer, New York Central, and developed by Assistant Secretary R. P. Ives, mechanical expert, Westinghouse Air Brake Company.

At the yesterday sessions three papers were presented, including "Type F-1 Lubricator for Steam-Driven Air Compressors," submitted by the St. Louis Air Brake Club and read by J. P. Stewart, general supervisor air brakes, Missouri Pacific; "Failure of Brake-Beam Suspension Parts and Their Maintenance," by President Clegg, and "Development of the Electro-Pneumatic Brake for High-Speed Control," by C. A. Campbell, New York Air Brake Company. Four other subjects will be presented the two sessions to be held today.

## President Clegg's Address

It is indeed gratifying to meet you again after this long interval. I think you all know the circumstances that brought about the suspension of our annual meetings after that of 1930 in Chicago. Primarily, of course, it was the world business depression which became so acute that everyone found it necessary to curtail many activities and retrench in every possible way. We are greatly indebted to those who so pleasantly granted our request and made it possible for us to resume our annual meeting here at this time.

Since we last met new fields have been explored to meet the ever-changing demands upon transportation, entailing much investigation, research and development with attendant costs, that have brought many devices, both new and novel, within our field of endeavor and there is much for us to do. During the recent past the country's basic transportation system has been making new history principally with equipment designs, rapid dispatch and luxurious comfort and it will no doubt continue to anticipate and meet the public's demands with speed, the prime factor both in movement and action.

This quite naturally brings braking problems to the

surface of a new and different character, taxing heavily the skill and ingenuity of those who design and build these new and modern appliances that permit this new chapter of history to be written into the records of transportation achievement. These men cannot go along thinking only in terms of train speed; they must also think in terms of brake effectiveness, train slack, speed of action, control of movement, flexibility, practical construction, maintenance, speed and accuracy in production, investment, the field or market for the device, its cost and many phases entering into new development. Consequently, their problems are many and difficult and such men have our warmest admiration.

We seem to be swimming with the stream of progress in an almost unbelievable age of scientific achievement and we must keep in step with the march of things. We must continue to give our undivided attention and diligence to the new problems.

The care and management of these new and modern appliances quite naturally comes within our jurisdiction and we must also become equal to our task which calls for a keen appreciation of the finer art, intensive education by those in charge, greater care and skill in handling, adequate facilities and very wise judgment if our employers are to obtain the most economic and satisfactory service for their money so invested.

Present passenger-train speeds, in some instances, are approaching air-plane speeds of a few years ago. Under such conditions new and improved brake schedules are not sufficient in themselves; higher braking ratios must also be employed and it would appear that it is not so much a question of how high the braking ratios should be, but rather what we can tolerate with the fixed physical limits of wheels, brake shoes and rail adhesion. Nevertheless, brake equipments for the safe and effective control of such trains presents a very formidable problem and must naturally employ many revolutionary innovations.

Since the advent of higher freight-train speeds, traffic interruption, due to failure of truck brake-gear parts have become a really serious matter and the question of maintenance of these parts demands our immediate attention. Perhaps we shall have an opportunity to discuss this problem more in detail before our meeting closes.

Our association has always been deeply concerned with the safe control of trains, but we are now concerned more than ever before with the expeditious transport of merchandise. Traffic must move at much higher speeds than heretofore and without interruption. The schedules of train movements and their connections are timed with much greater precision than heretofore.

## Type F-1 Lubricator for Air Compressors

By the St. Louis Air Brake Club

The year 1868 gave us the earliest form of steam-driven air compressor for locomotive service. Since that time, the lubrication of either the steam or the air end of the compressor has been and is far from perfect. The hydrostatic lubricator has been used in an attempt to feed the correct amount of oil to the wearing parts of the compressor, but the regular compressor operation is subject to such extremely wide and variable conditions that any fixed rate of oil supply must be either excessive when the compressor operations are below the average, or such a supply of oil becomes entirely inadequate when the compressor is called upon to operate at or near its maximum rate. Such a method of lubrication is also un-

satisfactory, because during a locomotive trip over the line, the oil supply is reduced by the engineer when some such defect as an overheated bearing on the locomotive enforces the necessity of oil conservation.

When locomotives arrive at terminals, it frequently happens that the hydrostatic lubricator is shut off and when the readjustment of the lubricator is postponed or overlooked, the compressor may operate without lubrication for a considerable period. This is extremely detrimental because it increases the general maintenance cost, due to unnecessary wear. The shortened life of unlubricated packing rings and other parts often ends with breakage, thus resulting in unnecessary and expensive compressor failures.

It has been often said, and usually truthfully, that "the air pump gets more abuse than any other part of the locomotive," but we know that one of nature's fundamental laws strictly specifies that "you cannot get something for nothing." The total expense of unnecessary maintenance caused by the lack of lubrication, or by uncontrolled excessive lubrication, and including the indirect expense involved in compressor failure, makes up a sum which, if correctly computed, would be almost beyond belief.

The Type B oil cup has been in general use for some time and it represents a vast improvement over all former attempts to lubricate the compressor air cylinder. It will feed oil at a uniform rate and only while the compressor is working. However, the rate of feed for this cup is somewhat affected by the oil viscosity and temperature, so that as either a scientific or practical means for furnishing the best degree of air-cylinder lubrication, it leaves very much to be desired.

These facts are clearly indisputable and it is, therefore, obvious that the ideal compressor lubricator must be some form of a mechanically operated lubricator which will feed the minimum adequate supply of oil at a uniform rate to each compressor bearing surface. Furthermore, such a lubricator must maintain different rates of oil feeds for the several different compressor parts, and it must be arranged so that the several feeds can operate only while the compressor is working. A lubricator which meets these requirements in every respect has been designed and placed on the market. This lubricator, which is known as the Type F-1, is operated by a small air engine which is connected to the compressor low-pressure air cylinder.

### Description of the Lubricator

The type F-1 lubricator has six oil feed pumps which are operated by a cam driven by the air engine, and the rate of oil feed for each pump can be conveniently adjusted at properly designated terminals by authorized workmen. The oil-supply reservoir is divided so that a different kind of oil can be used for the steam and air end of the compressor, when this is deemed desirable. Four of the six pumps are mounted in the large oil-reservoir chamber which has a capacity of about two quarts, and the other two pumps are in the smaller chamber, which has a capacity of one quart. The larger chamber carries the oily supply for the governor and steam cylinders, while the smaller chamber supplies the oil for the air cylinder. Where the same oil is used for both steam and air cylinders, the chambers can be connected by removing a pipe plug.

The lubricator pumps are arranged to provide individual and independently adjustable oil supplies for each vital point of the compressor system, including both the air and steam end of the air-compressor governor; each

oil pump will function to feed a predetermined quantity of oil only when the compressor is working, and at a rate directly proportional to the compressor speed.

The air engine is arranged so that for each double stroke of the compressor, it will move the cam through a small increment of its rotation. As the cam rotates, it slowly lifts the lap-fitted pump plungers against a motor spring and the pump cylinders fill with oil. The degree of plunger lift is adjustable. Each pump plunger is released once during a revolution of the cam and its motor spring then forces the plunger downward with high velocity, thereby discharging the measured quantity of oil in the pump cylinder to the delivery pipe under high pressure. This snap action of the delivery stroke of the oil pumps greatly reduces any effect of leakage past the pump plunger, and thus insures a long life of reliable operation with a minimum maintenance cost.

The lubricator has a heating chamber which is connected to the compressor steam supply so that the oil in the lubricator can be maintained at a proper temperature to insure satisfactory operation. The body of the lubricator is lagged to insure additional protection for maintaining the proper oil temperature when the lubricator is exposed to cold weather.

It is not the purpose of this paper to give a detailed description of the design and operation of this lubricator, since the manufacturers have already done this in their descriptive leaflet No. 2458. This leaflet contains cuts of several drawings which relate to a complete description of the lubricator, its operation and several methods of installing the lubricator with air compressors.

The possibility of attaining a maximum operating efficiency, as well as a minimum maintenance cost, for steam-driven air-compressor performance by lubrication which is designed to be a perfect fit for the job, is highly appreciated by the St. Louis Air Brake Club, and we therefore wish to respectfully place our experience before you.

### Discussion

In response to a question about how the lubricator would work in temperatures of 50 below zero, Mr. Stewart said he would anticipate no difficulties since the oil chambers were lagged and steam heated.

W. H. Davies, superintendent air brakes, Wabash, asked if an examination of air-compressor parts after the use of this lubricator showed sufficient wear to necessitate change in adjustment of the oil feeds, and the reply was in the affirmative and that it had been found possible to cut down the feed to the air cylinders. Mr. Stewart said that the adjustment of the feeds, however, must be made solely by experienced maintenance men.

G. H. Wood, supervisor air brakes, Atchison, Topeka & Santa Fe, asked if oil is fed both to the low- and high-pressure cylinders and in varying amounts. Mr. Stewart replied that experience on the Missouri Pacific indicates the possibility of cutting down the high-pressure feed 30 to 40 per cent less than that to the low-pressure cylinders.

Mr. Wood also raised a question regarding the practicability of lubricating air compressors from a mechanical lubricator which operates only when the locomotive is running, and E. Von Bergen, general air brake, lubricating and car heating engineer, Illinois Central, said that on his road this method of lubricating air compressors has been used successfully for some time, with a marked improvement over results possible with the old hydrostatic lubricator. The locomotives in this instance, however, are used in long-run service and the air compressors

are not permitted to operate for any length of time, except when the locomotives are in motion.

## Failure of Brake Beam Suspension Parts

By W. H. Clegg

The failure of brake beam suspension parts on cars in interchange seems to be one of the most troublesome mechanical defects we have to deal with. By reason of this it is presented here, first, to bring it to the attention of those who may not appreciate its importance; second, for discussion from which we may be able to render some assistance; third, to enlist the active and persistent effort of our individual members, as far as their jurisdiction will carry, in a campaign for better maintenance of these parts, and, fourth, to encourage the faithful observance of such regulations and requirements as the Mechanical Division of the A.A.R. may adopt.

Now, what can we do? Before we attempt to answer the question, let us analyze the situation by asking, "Why do brake beams fall down en route?" The answer may be found within two general causes, namely; equipment design, and inadequate maintenance.

### Equipment Design

It is a reasonably fair statement to say that all the older designs of brake beam suspensions are such that the bearing area of hangers, hanger pins, bolts, brackets, etc., is totally inadequate, consequently wear, and excessive slack develops in a relatively short time and this inadequate bearing area is directly responsible for much permanent slack in, and ultimate failure of, brake beam suspension parts.

The general run of earlier types of brake beam suspensions do not lend themselves to convenient and economic correction. Frequently the parts that should be renewed are of such design or shape and so different from those common to the handling line that they have to be made to suit. Where such repairs must necessarily be made in train yards, substitutes, in many cases, seem to be the only expedient to permit the car to go forward.

All these obsolete designs, however, are not necessarily confined to earlier days, many cars built within the past eight or nine years are fitted with designs that will always be a source of frequent trouble and difficult to maintain. This question of design includes the quality and treatment of materials for such parts. For years most railroad have used the lowest grade of material for hangers, pins, bolts and rods of various shapes and sizes, very largely by reason of cost, believing that it was satisfactory and cheaper. It is only recently that better quality steels with proper treatment, at somewhat higher prices, have been given the careful consideration this important phase of the subject demands, although improved designs with better quality materials have been available for some years.

### Inadequate Maintenance

Inadequate maintenance may be defined as failure of the car owner to maintain these parts in a safe and satisfactory condition.

Prior to 1929 there were no condemning limits of wear for these parts on cars offered in interchange; since then, however, certain condemning limits now shown in the

\* Chief inspector, air brakes and car heating equipment, Canadian National.

Interchange Rules have been in effect, but these seem to be inadequate and should be very much more restrictive in view of the higher speeds at which freight trains are operated and the importance of their safe and prompt movement.

We find cotter pins, cotter keys, split pins or split cotters, etc., (different terms for the same thing) missing, worn, improperly applied, too small in diameter and substitutes. Missing cotter pins are due primarily to the failure of repairmen to apply them after repairing hanger connections, or, if they do apply them, fail to properly spread or open them. This is due, in some cases, to negligence, in others to misplacing the cotter pin removed and failure to have another immediately available, or lack of a proper tool to spread cotter pins quickly and effectively. In others, the pressure of time to get trains out quickly prompts the use of substitutes.

Improperly applied cotter pins imply that one leg of a cotter pin is passed through the hole in the hanger pin, with the ends bent around the pin, or where a cotter pin is not properly spread or opened until it is tight.

We find also the use of  $\frac{1}{4}$ -in. and  $\frac{3}{16}$ -in. cotter pins in  $\frac{7}{16}$ -in. diameter holes, the use of nails, wire or other substitutes for the proper  $\frac{3}{8}$ -in. cotter pins.

Excessive wear of hangers, hanger pins, bolts, rods, etc., due primarily to inadequate bearing area in the original design, together with the inability conveniently to replace them or restore such worn conditions to normal.

In correcting the worn condition in brake hanger brackets, we cannot do very much with malleable cast brackets or column castings. In the case of cast steel the worn holes can be restored by welding. In any case, restoring the original diameter of these pin holes is a major repair job and can only be satisfactorily handled in repair shops or well-equipped repair tracks. The simplest and most satisfactory way would be to bore them out and bush them with hardened bushings, but, in general, there is not sufficient material surrounding the worn holes to permit of this being done. Therefore, worn hanger pin holes will be a permanent condition of slack and can only be properly corrected when cars are in shops undergoing other repairs, which involve removing the trucks from underneath the car.

This condition of excessive slack produces more rapid wear of all other associated parts, particularly cotter pins, including the surfaces between the brake head and brake shoe, unless the brake shoe key holds the brake shoe tightly against the brake head throughout the life of the shoe.

The higher present-day speeds cause more rapid wearing of truck brake rigging parts, particularly in brake beam hangers and attachments. The car wheel is principally responsible for this, in spite of the remarkable progress made in recent years in the manufacture of car wheels. We must consider such wheel defects as slid flat, comby tread, brakeburn, shelled out, worn through chill, etc., encountered daily, but well within the condemning limits of interchange and the handling line may not remove wheels for such defects except at its own expense.

#### Wheel Rotundity an Important Factor

Freight car wheels are as round as expert foundry practice can make them; however, we may expect to find some eccentricity, or out-of-roundness. It is also reasonable to expect some freight car wheels to be out of balance dynamically.

It is common to find the rails rough with spots in the rail head of some size adjacent to coaling stations, water

cranes, etc., that shake the truck frame, setting up heavy vibrations when passing over these places, even at moderate speeds. The movement of freight trains over inter-sections, etc., at high speed transmits violent shocks and vibrations to the truck frames and brake rigging. Brake shoe keys have been seen to bounce completely out of the brakeheads at these points.

When we realize it is not uncommon for freight car wheels to revolve at more than twice diameter speed, the slight inequalities in the periphery of the wheel tread or rail head produce vibrations in the truck frame of such frequency and magnitude that wear and slack in brake beam suspensions develop in a much shorter period of time than heretofore, particularly on cars that are very active or move more frequently in higher speed trains.

#### Recommendations

That we make a personal survey of these conditions on freight trains in our respective territories.

That we follow this with a detailed report to the proper officer, giving specific instances of the glaring and unsatisfactory conditions found.

That car department forces be urged to tighten up on the inspection of brake beam suspension parts.

That, where time permits in train yards, every effort be made to renew such worn parts as hangers, hanger pins, bolts, rods, cotter pins, etc.

That, when cars are on repair tracks or in shops for repair, the brake beam suspension parts be closely checked, and where such parts are worn to the limits prescribed in the Interchange Rules, they be corrected before the cars are returned to service.

That we endeavor to make personal contact with as many train yard foremen and inspectors as possible and impress upon them the importance of renewing worn and missing cotter pins, always making sure to reapply them after repairs, also to see that they are properly spread.

That we take suitable action with those responsible for designs and materials for suspending brake beams, bringing to their attention the general conditions prevailing, all with the view of having everyone concerned fully appreciate the importance and need of improved brake beam suspension designs and better quality of materials for repairs and conversions, as well as for new installations.

That we endeavor to see that everyone concerned is familiar with the limits of wear prescribed in the interchange rules and that they fully understand their meaning.

We might also help materially by familiarizing ourselves with such recommendations, regulations or requirements that the Mechanical Division of the A.A.R. may issue from time to time, and encouraging their faithful observance by all concerned, keeping in mind that whatever regulations or requirements that body may issue are the result of a careful study by the respective committees assigned to the subject, who, I believe, know what is best for the general good.

I assume we are in accord that present operating conditions are severe with respect to wear of truck brake gear parts. With this appreciation before us it is to be hoped that all new designs will be such as to provide the very maximum protection against both failure and wear, together with consideration for future convenient and economic maintenance.

(The proceedings will be continued in Monday's Daily.)

# Mechanical Division Considers Problems of Locomotive Design

Individual paper by W. H. Winterrowd and the report on Locomotive Construction were thoroughly discussed

**T**HE second session of the sixteenth annual meeting of the Mechanical Division at the Municipal Auditorium Thursday morning listened to a paper by W. H. Winterrowd, Vice-President of the Franklin Railway Supply Company, Inc., which clearly depicted the developments recently made in the design of locomotives and their appurtenances, and the part which engineering research has played and must play in increasing the efficiency and performance of these motive-power units. More specifically, Mr. Winterrowd discussed the relation of boiler design to the higher steam pressures

and temperatures now being used and the economies to be effected by innovations and renovations in air preheaters, economizers, condensers, and variable exhaust nozzles, and by a study of the relation between grate area, firebox volume and firebox heating surface. Modern locomotive design incorporating use of improved materials to reduce axle loads and wear and thereby decrease maintenance cost and improve operating performance was clearly outlined.

The paper was followed by the report on Locomotive Construction.

## Research and Steam Locomotive Development

Accelerated progress brought about through co-operative research—Higher speeds and capacities show the need for new test plants

By W. H. Winterrowd

Vice-President, Franklin Railway Supply Company, Inc.



W. H. Winterrowd

The steam locomotive is the backbone of railroad transportation in this country. It will continue to be that backbone for many years to come.

Those statements should not be construed to decry the value of some other forms of railroad motive power which, in more or less restricted service, or under certain conditions of operation, have proved their great value to the railroads. Neither should they be construed to decry the very great importance of continual research, development, and experimentation in connection with other forms of motive power which indicate promise of real value.

The very best form of motive power for any specific set of conditions is that form of power that will produce the desired results with the greatest possible net return upon the total investment involved. That is merely a good business axiom, and railroading is a business, a highly developed type of business, a fact that some of its detractors have been slow to recognize.

Any business to succeed must make progress. In order to make progress there must be continual study, research and experimentation. If some form of motive power can be developed that will do as much, do it as cheaply, and net a greater return upon the investment than the truly best steam locomotive, that type of motive power will eventually supplant all steam locomotives. Nothing like that is upon the horizon today.

From time to time the press has presented to its readers statements conducive to the belief that the modern steam locomotive has reached a point where it cannot meet practically and economically the traffic conditions of today. Nothing could be farther from fact. The possibilities of increased efficiency and capacity

guarantee a continuing progress. Does the general public know that?

Does the public realize that in its field, the properly designed, modern steam locomotive offers the railroads an unequalled investment, both from a first cost and a return-upon-the-investment basis? The possibilities of the steam locomotive hold such great potential value that the railroads cannot afford to be indifferent, or deceive themselves. Neither should the public be permitted to deceive itself.

The performance of the steam locomotive of today is often grossly misrepresented, either deliberately, or by entire or partial lack of proper presentation of design and performance facts. Data often quoted against the steam locomotive is abstract. It is unfortunate that the critics of the steam locomotive often make comparisons that fail to take into account the latest and proved facts of performance of well designed, modern locomotives. In making any comparison involving the steam locomotive, only the results possible with the best and most efficient steam locomotives should be taken as the basis of comparison. Otherwise a costly and erroneous conclusion will result. In its field, the well designed steam locomotive does not have to concede anything to other types of motive power.

Without great publicity, steam locomotive development has progressed steadily, ever keeping pace with the growth in traffic and the resultant demand for increased power and efficiency. The record of that development is an outstanding one. It has not received the full measure of recognition that it merits.

It is difficult to sum up briefly such an important story of development. The accompanying table, covering both freight and passenger locomotives, is a brief summation worthy of emphasis because it stresses one of the outstanding phases of locomotive development that phase covering the truly remarkable increase in maximum cylinder horsepower and its relation to the number of driving axles and the weight upon them.

The freight locomotive tabulation shows that in 29 years max-

imum cylinder horsepower per driving axle has increased from 260 to 1171, an increase of 350 per cent. At the same time the horsepower per ton of weight on driving wheels increased from 12 to 31.4, an increase of 162 per cent.

The passenger locomotive tabulation shows that in 42 years maximum cylinder horsepower per driving axle has increased

#### Freight Locomotives

Year	Type	Max. I.hp.	Hp. per driving axle	Avg. wt. per driving axle	I.hp. per ton on drivers
1904.....	2- 8-0	1036*	260	43,300	12
1914.....	2- 8-2	2500	625	60,000	20.8
1915.....	2- 8-2	2837*	709	59,000	24.0
1922.....	2- 8-2	2965	741	62,000	23.9
1925.....	2- 8-4	3890	972	62,000	31.3
1933.....	2-10-4	5855	1171	74,500	31.4

#### Passenger Locomotives

Year	Type	Max. I.hp.	Hp. per driving axle	Avg. wt. per driving axle	I.hp. per ton on drivers
1895.....	4-4-0	522*	261	28,000	18.6
1904.....	4-4-2	1224*	612	55,000	22.2
1910.....	4-4-2	1958*	979	64,000	30.5
1912.....	4-4-2	2355*	1177	70,000	33.6
1914.....	4-4-2	2488*	1244	66,500	37.4
1915.....	4-6-2	3183*	1061	67,600	31.4
1927.....	4-6-4	4075	1358	62,000	43.8
1937.....	4-4-2	3200†	1600	70,000	45.7

\* Test-plant data.

† Calculated.

Others from road tests.

from 261 to 1600, an increase of over 500 per cent. At the same time the horsepower per ton of weight on driving wheels increased from 18.6 to 45.7, an increase of 146 per cent.

The development tabulated above is a record of note, especially when one takes into consideration the physical limitations imposed upon the locomotive, particularly the restricted limitations of overall dimensions.

The above accomplishment was made during an era, the close of which has seen great changes in the method, technique, and organization of research work. The change has been such that today railroad research work is on a more highly organized and efficient basis than ever before. As a result, the railroads stand to profit to a greater extent and more promptly than at any other stage in their history, not only in matters of steam locomotive development, but in other matters as well. In other words, the progress of research is being accelerated.

This can be illustrated diagrammatically. Many years ago, progress was based upon a relationship between railroads and producers of material and equipment as shown approximately in Fig. 1.

The radiating lines from railroad A and railroad B represent the producers of material and equipment required by the railroads. The line connecting railroad A and railroad B repre-

sents the contact between the railroads. Under this set up, each railroad, independently and in its own way, conducted research with the various producers.

At an early date the railroads formed themselves into an association. Under that arrangement there was developed a relationship that is illustrated approximately in Fig. 2.

The formation of the Master Mechanics and Master Car Builders Associations provided a clearing house for the results of research and study and provided an arrangement which made possible more prompt progress and facilitated efforts which led to important and valuable standardization. The value of these mechanical organizations has been incalculable. In Fig. 2, only the Mechanical Associations are depicted. Other department associations were formed which bore the same relationship to the general picture.

The latest stage in organized relationship is shown approximately in Fig. 3.

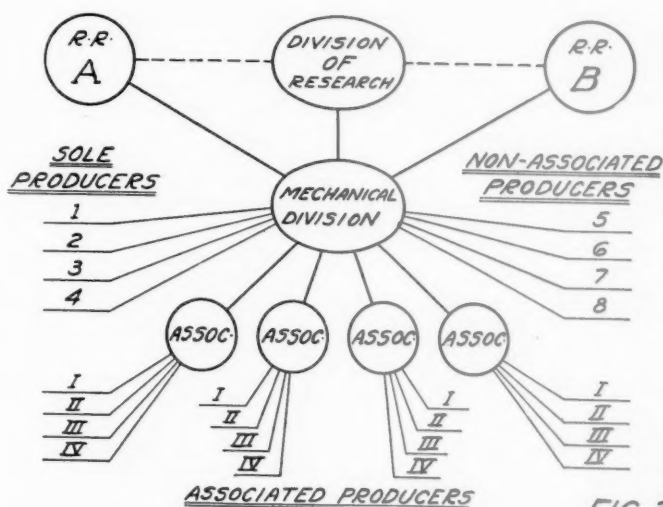
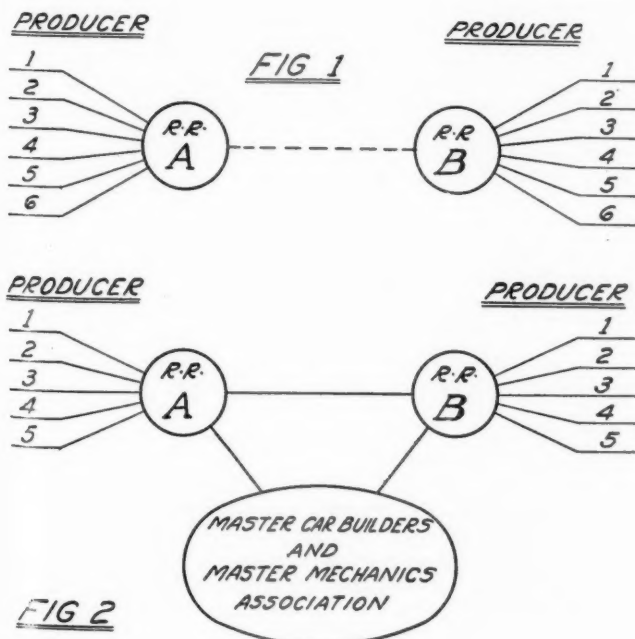
There are several significant things to note in Fig. 3. First, a division of research has been introduced. Second, that quite a number of producers have organized associations that conduct a great deal of their own research which is made available to the railroads through a single channel leading to the Mechanical Division and its proper committees.

A few examples will serve to illustrate this relationship. One of these is the Association of Coupler Manufacturers. It is difficult to stress adequately the value to the railroads of the research and work conducted for many years by that Association in conjunction with the Coupler and Draft Gear Committee of the Mechanical Division in the matter of the development and adoption of a single standard coupler with all its parts standardized or interchangeable. Another example is the Association of Manufacturers of Chilled-Car Wheels. That association conducts its research and study and transmits the results thereof to the Mechanical Division through the Car Wheel Committee. Another is the Draft Gear Manufacturers Association which transmits the results of its research and study to the Mechanical Division through the Coupler and Draft Gear Committee. Another outstanding example is the Association of Steel Wheel Manufacturers whose work with the Wheel Committee of the Division has been of importance to the railroads. Any problems or projects demanding unusual research are submitted to the Division of Research. That division in its work contacts the railroads and the Mechanical Division as well as the producers and any other source of information that may be desirable.

#### Value of Associated Research Evident

The value of associated research by producers is evident. It simplifies the relationship of the producers to the railroads as far as research is concerned.

However, in Fig. 3, it will be noted that there are some pro-



Diagrammatic Representation of the Evolution of Relationships Between Railroads, Producers, the Mechanical Division And Producer Associations

ducers not organized into associations. Each such producer deals directly with the Mechanical Division and its committees. An outstanding example of research conducted by the railroads in connection with individual producers is the recent and valuable work conducted by the Division of Research in connection with air conditioning of passenger equipment.

Another example of contact with the Mechanical Division on the part of unassociated producers is that of the locomotive builders who are permitted to have representation on the Locomotive Construction Committee.

Fig. 3 should not be construed to indicate that various producers do not, and should not, contact with individual railroads. Individual contact has every justification. The diagram is intended to emphasize the value of systematized cooperative effort in the solution of many important and common-interest problems.

It goes without saying that there will always be some producers who are the sole manufacturers of certain material and equipment. Naturally, their problem of research and relationship to the railroads will be through the single line approach to the Mechanical Division and to the individual railroads.

Within practical limits, there is much to be gained by both railroads and producers, if the trend toward associated producer research is encouraged to grow. Co-ordinated and co-operative research results in valuable and accelerated progress.

The importance of an accelerated trend toward producer association research was emphasized by Dr. L. W. Wallace, Director of Equipment Research of the Association of American Railroads, who, in a recent address before the Atlantic States Shippers' Advisory Board, classified research work under three heads: fundamental, creative, and applied. Fundamental research is that done without commercial motive. Creative research is that done by a manufacturer to develop new and improved commodities. Applied research deals with the ways and means of applying industrial products to the most practical use.

In an editorial, the *Railway Age* stated—"Obviously, it is the third category—applied research—which concerns the railroads, as they are users, not manufacturers of commodities. Creative research for the railroad industry is the job of those who sell them equipment and materials."

The foregoing outline of existing, or possible, relationship of producers to the railroads, indicates that valuable information in connection with locomotive materials, design and performance, can be made generally available and with reasonable promptness.

Development of the steam locomotive at a greatly accelerated rate introduces an important problem. The solution of that problem will, in large measure, determine the future rate of locomotive development.

In the past, the rate of development was such that the matter of obtaining design and performance results upon which to base progressive development was not unduly complicated. But with accelerated development, brought about by co-ordinated and co-operative research, the matter of obtaining design and performance results without long drawn-out delay, becomes a problem. Limited locomotive testing plant facilities in this country constitute a phase of this problem.

### New and Modernized Test Plants Needed

It is in the interest of the railroads, as well as producers, that when an improved steam locomotive proves its worth in operation, the facts of design and performance be determined accurately and made available with reasonable promptness. No one railroad should be asked, or expected, to bear the burden of the expense involved because it is a matter of importance to all railroads. One railroad in this country has accomplished very much in the development of locomotive performance facts and it is no exaggeration to state that the results of that railroad's study and research have been of incalculable value, not only to all railroads, but to the builders of locomotives and producers of locomotive equipment.

In the future, in order to carry forward development as rapidly as possible, every practical, available locomotive testing plant in this country should be at work continuously. Such test plant work should be supplemented by road tests when necessary, or desirable. All road tests should be made under adequate and skilled supervision and by approved methods that guarantee as far as possible the minimization of variables, including the hu-

man element. A poorly conducted test which gives erroneous results is worse than no test at all. Furthermore, in order to assure the prompt and accurate application of testing-plant and road information so secured, the railroads should see to it that the size and skill of their engineering staffs are adequate to meet the ever increasing demands.

Locomotive testing plants gave a great impetus to locomotive development in this country because they afforded the only means of obtaining accurate data for comparative purposes. With the means available for making exact comparisons, locomotive development was placed upon a true engineering basis.

The return of the railroads of this country to private ownership directly after the war marked the advent of a new type of railroad operation that has been developed to a high degree of efficiency. The change in operation has been marked by long locomotive runs, increased train speeds, and by a higher availability and more intensive utilization of equipment. The change resulted in a radically different locomotive problem and in development of locomotives which in matters of sustained high horsepower and high speed seriously tax the capacity of locomotive testing plants in this country. The construction of new testing plants, or the modification of existing ones, which will permit the testing of the modern locomotive throughout its full range of speed and capacity would mark a signal step in further acceleration of steam-locomotive development. Sound progress is made by taking one step at a time and successful future steps will depend upon a full and prompt knowledge of each step as it is taken.

What trend will steam locomotive development take in the future? It is not always wise to predict, but there are some phases of development that are full of promise to the railroads. It is beyond the scope of this paper to mention all of them but a few of the most important can be touched upon briefly.

### Steam Temperature

At the present time it would seem that with the conventional type of reciprocating engine the practical upper limit of steam temperature has been closely approached. This is not due to any lack of ability to obtain higher temperatures.

Any research that will result in improvements that will permit the practical use of higher steam temperatures will effect a saving in the steam consumption per indicated horsepower.

Poppet valves seem to offer a means for the elimination of the difficulty of adequately lubricating piston valves at higher steam temperatures.

### Boiler Pressure

The development of the steam locomotive has seen great progress in improved boiler performance, both from a capacity and efficiency standpoint. It has been one of the outstanding phases of locomotive development.

However, during the past few years there has been an ever increasing trend toward the use of higher boiler pressure. With the present type of staybolted boiler, a pressure of from 300 to 325 lb. can be considered the present maximum upper range.

At the present time, the two chief factors for consideration in connection with the use of these so-called higher steam pressures in the conventional steam locomotive are, first, the possibility of obtaining improved cylinder performance, and second, the possibility of the use of smaller cylinders, thereby reducing cylinder spread, and the possibility of some reduction in the weight of reciprocating parts.

The problem of improving cylinder performance by the use of increased boiler pressures will be touched upon later.

### Boiler Design and Fuel

Although the development of the locomotive boiler has been outstanding, there are still factors that merit further research. Additional study between the relationship of grate area, firebox volume, and firebox heating surface and the other proportions of the boiler and its appurtenances, in conjunction with various types of fuel, should be of value.

This is important if one keeps in mind that, today, every effort is being made to increase the so-called cruising range of the

steam locomotive. Many of the most modern locomotives are being equipped to burn oil in territories where that type of fuel has never been used before.

Pulverized coal was tried on locomotives many years ago. Locomotive development had not reached a stage where the use of such fuel could be made successful. Its success in stationary practice has been outstanding. It is not unreasonable to feel that the time will come when the use of pulverized coal on locomotives will be given further consideration. Experience indicates that its successful use on locomotives may bring about radical modifications in boiler design.

Experiments are being conducted in preliminary heat treatment of coal which consist of an effort to drive off the gases which are responsible for spontaneous combustion. With this accomplished, the problem of proper air mixture with the use of pulverized coal may be greatly simplified.

During the past several years some experiments have been made with boilers other than the strictly conventional types. The results of those experiments when available will be of great interest. Furthermore, steam boilers that depart radically from conventional types, such as the forced circulation types, are being built, and their practical applicability to the steam locomotive will be a matter of great interest to railroads and locomotive designers. Their successful development may greatly affect locomotive design.

### Steam Space

An important matter in conventional boiler design is adequate steam space. Reduction of steam space is a serious handicap in the full development of power. Careful consideration should be given to the maintenance of adequate steam space volume as related to the area of the water at normal working levels, at the same time keeping in mind the most advantageous location of the steam dome.

### Air Preheating

Some experiments have been made in the use of preheated air for locomotive combustion. Modern stationary power plant practice takes full advantage of air preheating but can do so because space limitations are not restricted. Space limitation seriously complicates the problem on the locomotive. However, if full advantage cannot be obtained there may be enough gained to afford valuable protection to the firebox structure. The possibilities of improved performance and reduction in cost of firebox maintenance warrant a continuing interest in the subject.

### Economizers

Economizers have been tried as a means of utilizing waste heat from smokebox gases, but again the problem is an involved one on account of space and weight restrictions. The possibility of increasing the temperature of boiler feed water, improving boiler capacity and efficiency, and reducing the fuel rate, makes the problem of a practical economizer a difficult but interesting one.

### Condensing

The development of the steam locomotive has brought about a steady reduction in the amount of steam required to develop an indicated horsepower hour. Thirty years ago approximately twenty-eight pounds represented the best road attainment. Today, the best attainment is approximately half that amount. The trend of locomotive development indicates the possibility of still further reduction. Twelve pounds of steam per indicated horsepower hour does not seem beyond the range of practical possibility.

In the past, the problem of a practical locomotive condenser has been complicated by the large volume of steam involved. With the steady reduction in the amount of steam required to develop horsepower, the complications due to volume have been reduced. The development of a practical condenser will bring about a still greater reduction in the water rate.

The outstanding problem, with space and weight restrictions, is to get enough cooling surface to carry off heat. To provide enough condensing surface to permit exhausting steam into any

considerable vacuum, such as in stationary practice, will require condensers beyond the size and weight limitations of existing locomotives. For that reason, the development of a practical condenser will undoubtedly follow the lines of design that will accomplish a reduction in back pressure as far as possible, probably to atmospheric pressure. Any further gain, within practical limits, will be of value.

There are many problems to solve in the development of a practical condenser and their solution may result in modifications of boiler and locomotive design. However, the solution of the problem would bring about steam rates and thermal efficiencies beyond those possible at present. Such a goal is worth serious consideration. Furthermore, from a practical railroad operating standpoint, it would greatly increase the cruising range of the locomotive and be of great economic value on those railroads that traverse desert country and on those where the supply of water is a problem.

### Variable Exhaust Nozzle

Variable exhaust nozzles are used extensively on foreign locomotives. Their development has been due in large measure to the importance of fuel conservation. However, they are important factors in the reduction of cylinder back pressure, and a corresponding increase in cylinder power. In the locomotive of today the fixed nozzle is a compromise. It must provide enough blast to burn fuel in the low speed ranges, which imposes a restriction on improved cylinder performance at higher speeds.

With the advent of improved steam distribution involving the possibility of very sudden and accentuated exhaust blast, the effect on grate-carried fires may be softened by refinements in draft, grate, and nozzle design.

### Improved Cylinder Performance

Conventional types of long cut-off valve gears place a definite limit upon improved steam distribution. Foreign designers have not been slow in attempting to improve steam distribution in the cylinders with the result that poppet valves are in service on many locomotives. Trial applications have been made to locomotives in the United States and the latest development seems to indicate that poppet valves can be successfully adapted to operating conditions in this country.

With conventional long cut-off type valve gears the minimum practical cut-off is approximately 25 per cent. This is due to the inherent valve events produced. In other words, cut-off below 25 per cent with conventional long cut-off valve gears, results in corresponding earlier release and increased compression and preadmission, thus making the use of longer cut-offs a practical necessity. Carried to a short cut-off extreme, the conventional long cut-off valve will simply travel slightly more than its lap and lead and thus reduce port opening into the cylinder to an extent that is utterly impractical.

In order to obtain the greatest advantage from high boiler pressure an increase in the steam expansion ratio is necessary. To obtain this in simple cylinders, a means must be provided to make practical the use of cut-offs shorter than 25 per cent. Poppet valves with suitable driving and control mechanism provide this means. In addition, the poppet valve principle provides a practical means for using separate intake and exhaust valves, thus making possible a separation of the heretofore fixed relations between admission, cut-off, release and compression. Furthermore, they provide rapid and full port opening and a corresponding increase in mean effective pressure.

Another advantage of considerable importance in some territories is the fact that the poppet valve principle permits the valves at each end of the cylinder to be held off their seats so that when the locomotive is drifting communication is established between both sides of the piston by means of short passages of adequate area, resulting in an ideal drifting condition.

The poppet valve principle also introduces the possibility of higher piston speeds and higher horsepower outputs.

The possibilities of improved locomotive performance with such valves are so great that a practical adaptation of the principle to the conditions of operation in this country, combined with its proper inter-relation to the locomotive as a whole, will mark a great step forward in locomotive development. Experiments have been made with other types of valve designs which

provide independent inlet and exhaust valve control but, to date, the poppet valve principle seems to have commanded the greatest interest due possibly to its comparative simplicity.

In passing, it is only fair to call attention to the fact that abroad, particularly in France, the compound multi-cylinder locomotive has been developed to a high stage of efficiency, resulting in remarkable cylinder performance.

Experience in this country with compounding as a means of improving cylinder performance has resulted in a general feeling that it does not yield enough advantage of economy to offset its complications, especially when our comparatively low cost of fuel is taken into consideration. This feeling undoubtedly has been largely influenced by the fact that most of the experience was gained under conditions of low, or medium boiler pressure with comparatively low steam temperatures. It is not beyond the range of possibility that with the use of higher boiler pressures and steam temperatures than are generally being considered today, the principle of compounding may receive additional consideration. A few locomotives have been built in this country embodying those principles.

### Driving Axle Loads

The best locomotive design involves a construction in which maximum power is produced with minimum practical weight upon driving axles.

During the major period of locomotive development, there has been an increasing trend toward higher axle loads. Some years ago, 72,000 lb. per driving axle was considered high. Today such loads are more or less common. Some locomotives even have higher axle loads.

When considering driving axle loads, they must be considered in conjunction with horsepower output. The outstanding increase in horsepower output per driving axle that has taken place in locomotive development has been stressed in a previous part of this paper, and it would be unwise to say the limit has been reached, but the additional point to stress is the fact that it is a fundamental of best design that driving axle loads should be no greater than practical operation makes necessary. The minimization of driving axle loads depends chiefly upon the factors of material, fabrication and fundamental design.

As driving axle loads have increased, the problems of track and structures and their maintenance have grown in importance. This has resulted in growing effort to provide locomotive design and construction that minimizes as far as possible the effect upon the track of those factors of design that have accompanied increases in locomotive power and speed. Interesting and valuable accomplishment has been attained by improvements in material and design. However, if reduction in axle loads can be combined with such improvements, without any sacrifice of the desired horsepower output of the locomotive, the value to the railroads in lower capital expenditures and reduced maintenance of track and structures is so evident as to justify every effort toward this end. Today there is a steadily growing effort to attain the maximum horsepower output that up to now has been associated in the minds of railroad men with driving axle loads of 70,000 lb. or greater, but to attain it with materially decreased axle loads.

The effort to lower driving wheel loads necessarily imposes a reduction in starting power per pair of driving wheels, as starting power is determined by the factor of adhesion. At the same time, the urge to higher train speeds means increased power output of locomotives. This of necessity involves high boiler capacity.

For those reasons the designer finds himself compelled to meet lower values of starting power per pair of driving wheels and higher power outputs per pair of drivers at operating speeds.

The reduction in starting power which results from the above condition can more than be made up by the use of supplementary power applied to what normally would be non-adhesive weight carrying axles and a proper balance of starting power and power at speed thereby secured. This solution of the problem presented by high power capacity locomotives with relatively light driving wheel loads is being embodied in a number of modern designs. Further embodiment of this principle will mark an exceedingly important stage of locomotive development.

The advent of stronger materials making possible a saving in weight with no decrease in strength has opened up the field for

reducing the weights of locomotive parts. Progress has been made in this direction and further progress is evident. Progress is also being made in the development of materials that may make practical the use of the higher steam temperatures previously mentioned as a desirable goal of attainment.

There is an important point to be mentioned in the use of improved materials. Some years ago, when alloy steels were first introduced into locomotive construction, the results were not entirely satisfactory. This was in some measure due to the fact that proper information in connection with the use and handling of the material did not receive a sufficiently wide distribution. This brought about some degree of reaction which happily is now diminishing. As improved materials prove their worth, all information necessary for its proper use, maintenance and inspection should be given the widest distribution to all concerned.

It is a fundamental of good locomotive design that any excess weight is uneconomical. The use of improved materials is an important factor in adhering to that fundamental.

### Fabrication and Wear

The matter of fabrication and design to reduce the number of parts and thus decrease the cost of maintenance is a matter worthy of continued interest. Some remarkable progress has been made in this direction with steel castings. An experiment of outstanding interest is an all-welded boiler that will shortly go into service. The development of the locomotive to a stage of maximum efficiency is to some extent purchased at the expense of locomotive simplicity. The results cannot be attained otherwise. This is a matter that should be considered in a broad business sense. The sacrifice of the old-fashioned, so-called, simplicity is a small matter compared to the greater returns made possible with the improved unit. It is a business matter and should be looked upon in that sense without prejudice.

Progress has been made in developing locomotive wearing parts that reduce friction and reduce rates of wear. Further progress is possible. Any improvements in materials, methods of lubrication or design of wearing and bearing parts that will assist to keep the locomotive in continuous service and reduce the cost of maintenance are worthy matters for continuous study and research.

### Driving Wheel Diameters

The trend toward increased train speeds has brought about a steady growth in the diameter of driving wheels. Today, there are freight locomotives in service with driving wheels ranging from 70 to 77 in. in diameter. The maximum driving wheel diameter used recently in the U. S. A. for high speed passenger engines is 84 in.

The proper determination of driving wheel diameter depends largely upon the speed at which it is desirable to develop maximum horsepower. Involved in the determination are other factors such as profile character of the divisions over which the locomotive is to be operated, wheel base, weight, and size of boiler as related to capacity.

Much is to be gained by the use of driving wheels as large in diameter as practical considerations will permit. Under certain operating conditions, the use of 90-in. or greater diameter driving wheels on ultra high speed passenger locomotives presents the possibility of definite advantage, particularly in the matter of decreased locomotive maintenance and the matter of improved counterbalance and the resulting advantage not only in the locomotive itself but upon the track.

It may be contended that the larger diameter driving wheel will increase the difficulty of starting and will lengthen the acceleration period. The application of supplementary starting and accelerating power will eliminate that objection.

### Locomotive Tenders

The locomotive tender is also an important factor in proper locomotive design. Tenders have been built where fuel and water capacity proved inadequate by a small margin. Not only should fuel and water capacity and the relation between the two receive the most careful consideration, but the advent of improved materials makes possible a reduction in weight. In the past, tank plate thickness has been selected with a view to proper strength

after considerable corrosion has taken place. The employment of non-corrosive materials should make possible the use of thinner plates and a corresponding decrease in weight.

It may not be amiss to mention here that results equivalent to an increase in water cistern capacity can be realized by utilizing the condensed exhaust steam made available by present feed water heating devices.

In some cases, locomotive tenders have reached a size and weight that have brought them up to the carrying capacity of the wheels and axles in six-wheel trucks. The use of light weight materials may help relieve this situation. On the other hand, it does not seem beyond the range of possibility that a practical eight-wheel truck can be developed. Such a truck would make possible greater tender capacity, in many cases resulting in a greatly increased economic advantage.

### Designing for the Work to be Done

The steam locomotive is an investment—one that involves a great deal of capital. The locomotive that will not produce the greatest possible return for the money expended is a poor investment. It is a liability when it comes to the balance sheet.

It should go without saying that before any locomotive design is selected, the purpose for which the locomotive is intended, and the conditions under which it is to operate, should be thoroughly analyzed and understood. This may seem elemental, yet there have been such studies that did not take into full account all the factors involved in the particular problem at hand.

In the days when maximum tractive effort was the primary consideration, the designer's chief problem was to provide a locomotive that would successfully handle a given tonnage over the ruling grade. The speed over the division was whatever could be attained.

With the advent of scheduled deliveries and higher train speeds, the problem became far more complicated. The time over the division is now of primary importance. In order to determine the probable time over the division with a given train and locomotive, the effect of acceleration and deceleration demands extremely careful consideration. Many variables exist in the resistance of the train, but, generally speaking, the laws of train resistance are fairly well defined and generally known, at least for the usual maximum operating speeds.

Experience to date has resulted in raising some interesting questions in connection with train resistance at ultra-high speeds and with light weight equipment. This is a matter that warrants continued study and research.

Generally speaking, a locomotive is designed to do two things. First, to start its load and get it up to operating speed. Second, to keep that load in motion at the desired speed. The most efficient locomotive, from the standpoint of railroad operation, is proportioned to produce highest efficiency, economy, and power in that range of speed in which it operates most, and provide it with the least practical maintenance cost.

The profile of the road, operating speed, and the load to be pulled, determine the power requirements, both in the starting and accelerating range and the operating speed range. The locomotive of greatest value to the railroads provides the best possible power balance in these two phases of operation. Experience has repeatedly shown that some locomotives can pull more cars at operating speed than can be satisfactorily started and accelerated. There is no practical advantage in running such a locomotive at excessively high speed to make up time lost by slow starting and acceleration. On the other hand, experience has shown that some locomotives can start far more cars than they can haul successfully at the speed of which the locomotive is capable.

A locomotive too big for the load hauled over the greater part of a division is uneconomical from a locomotive performance standpoint as well as a railroad operating standpoint. This is something that should be kept in mind when existing locomotives are used to haul the lighter weight trains that are coming into use due to the improvement in light weight materials. Any considerable reduction in train weight will result in such locomotives being worked in a relatively inefficient range. Under such conditions, any comparison with competing forms of motive power is misleading and will not provide a railroad with a true economic comparison.

A sound consideration of motive power as an investment in-

volves a reliable knowledge of the latest development in the arts of locomotive construction and operation and how they are related to the problem of increasing net earnings.

The proper selection and design of a locomotive for a particular job is a matter of vital economic importance to a railroad. It is not a matter to be decided lightly and in a few days. As a matter of fact, it should be given continuous study so that when the time for new locomotives arrives, the railroads and the builders do not have to make a forced and hurried study and conclusion.

It is a study that involves vital factors. It involves not only a thorough consideration of the physical factors of the property, but a thorough consideration of the nature of the business, both present and future; competitive forms of transportation, both present and future; the most advantageous assignment and operation of motive power; the character, condition, and obsolescence of existing equipment; the proper knowledge of the trends in car design and construction that may affect train weight and resistance; labor conditions; and a knowledge of how to consider all these and other factors in the light of a business investment. It is an engineering and an economic consideration that warrants thorough knowledge and the application of the best experience and highest skill available, both on the part of the railroad as well as on the part of the locomotive builders and accessory manufacturers.

In its field, the steam locomotive remains the simplest, most reliable mechanically, most flexible unit, involving lower initial and maintenance costs than any other form of railroad motive power that has been suggested. Its development has been most remarkable. With the knowledge, skill and vision that are now available, and with an ever increasing appreciation of the value of research, the steam locomotive of the future will continue to prove itself the backbone of railroad transportation in this country.

### Discussion

D. S. Ellis (C. & O.): One of the most important features brought out in this paper is the transposition in the fundamental basic requisite of locomotive requirements today. Where, in the old days, it used to be a matter of starting tractive force of the locomotive, today it is largely a matter of horsepower and, as brought out by Mr. Winterrowd, one of the most important questions to be settled—in fact, the very first question to be settled before asking our engineers for their recommendation as to the type, size and kind of locomotive required for a certain job, is to know what is expected of the locomotive in the way of hauling capacity, sustained speed, length of run, and the profile of the section of railroad over which the locomotive is expected to produce desired results. In defense of the railroads, I am convinced that this practice is being followed today.

The most vital and important branches of research and engineering for the development of the steam locomotive must of necessity be based on facts and truth, and an accumulation of these facts and truths, while not always favorable to a particular thought in the advance of the development, must be recognized if we are to apply the development in a practical way.

Among the most important items mentioned in this paper are steam temperature and boiler pressure. These two items go hand and hand in so far as the temperature of the saturated steam itself is concerned. As to the maximum temperatures available for superheated steam, it is my thought that little is to be gained at the present time in higher temperatures unless ways and means are developed to make more expansive use of the steam and then only after making certain that the ends justify the means.

**Boiler Design and Fuel.**—One of the largest single features entering into the present locomotive is provision of ample boiler capacity and, with the constant demands for increased efficiency in boilers, those responsible for the design of steam locomotives should continue their research covering the proper proportions of the component parts of the boiler; namely, firebox, flues, grate area and smokebox, along the lines of heating surface, volume and gas area.

**Steam Space.**—Hand in hand with providing ample steam space in a boiler it is highly important to locate the steam dome properly on a boiler, taking into account the gradient, curves and conditions under which the locomotives will operate.

**Air Preheating.**—One thing that we got out of air preheat-

ing was the so-called ash-pan damper which allows admission of the proper amount of air while the locomotive is running and protects the firebox, side sheets and staybolts from admission of cold air when the locomotive is standing and drifting.

**Variable Exhaust Nozzle.**—This is a subject which has been paramount in the minds of locomotive designers many years and holds further possibilities looking toward increased efficiency in steam locomotives. While it is also stated that the fixed nozzle as now in current use is considered by some as a compromise, we do not consider it as such, for we have found that a locomotive drafted in accordance with the present recommended practice of the Mechanical Division is not only satisfactory, but has proved to be economical.

**Improved Cylinder Performance.**—One of the most singular means of obtaining improved cylinder performance, based on our experience, has been, after determining the proper horsepower required and a normal speed at which the horsepower is required, to design cylinders so as to provide the most economical cut-off during the longest periods of sustained normal horsepower required. While the above-mentioned desired cut-off is one that possibly may be subject to discussion or variance in opinion, it can be easily found if proper analyses are made of performance tests now on record.

**Improved Materials.**—As regards the advent of stronger alloy materials I would call attention to the importance of proper education of shop craft and inventory of the practices, tools and machinery that should be used in conjunction therewith, for it is only on the proper use of the material and the care exercised in fabrication and treatment of this material that its success will depend.

**Driving-Wheel Diameters.**—In the past the maximum horsepower was based on approximately 1,000-ft. piston speed or thereabouts, whereas in the modern locomotive of today our maximum horsepowers are being developed at substantially higher piston speeds which apparently has to some extent played a big part in improving cylinder performance. It may be that we have not gone far enough looking toward a possible new ratio between stroke, wheel diameter and piston speed.

L. W. Wallace (Director of Equipment Research, A.A.R.): The paper contains many significant highlights. The first is the number of times and the emphasis with which reference is made to economy and to net return on the investment. The author states: "The very best form of motive power for any specific set of conditions is that form of power that will produce the desired results with the greatest possible net return upon the total investment involved." That is a fundamental statement. At times one wonders if such a fundamental principle has been at all times observed.

In discussing axle loads, light weight, and other developments, Dr. Winterrowd very rightly states that the value of these improvements to the railroads in lower capital expenditures and reduced maintenance of track and structures is so evident as to intensify every effort towards this end. The relationship between track and rolling stock, both from the design and operation of each, has not been given that consideration it should have received from the point of view of both investment in and the cost of maintenance of track, structures and rolling stock. Increased speed, sustained schedules, and denser traffic is focusing attention upon this relationship. There is need for increased and a closer cooperation between the engineering and mechanical departments with respect to such matters, and such closer and increased cooperation would, undoubtedly, redound to the credit of both the engineering and mechanical departments, and to the profits of the railroads.

Since I have been director of equipment research, I have endeavored to do two things—at least two things. One effort has been to debunk the conception of research that appears to exist in some circles and in some men's minds, and through the process of that debunking eliminate a large measure of that unfair criticism of the railroad industry, and of the railway supply industry to the effect that they have not been indulging in research.

Mr. Symes in his address yesterday morning gave you a brief definition of research which was correct. I selected it from the standard dictionary, Webster's, so that it could not be challenged as to the correctness of the definition: "Research is an organized, diligent investigation to discover facts." If each

of you as railway and railway supply men will carry that definition in your minds, you are not likely to be confused.

Now, the discovery of facts may relate to any phase of human existence and experience. It is, therefore, not something that has to be carried on in the cloister, or that has any mystical or mysterious aspects. Creative research is that type of research and development work that you manufacturers of various commodities carry on in order to be able to offer to your customers improved equipment, more economic equipment, materials, and the like. You, as producers, carry on creative research.

The railroad industry is a consumer, pure and simple. Therefore, its place in the research pattern is that of applied research. And it is that process, that organized, diligent process whereby the railroad industry endeavors to determine the facts with respect to performance, economy, and efficiency of the commodities that you offer to the railroads. It is that process whereby the railroads endeavor to ascertain whether those things you offer would economically and satisfactorily meet the every-day operating problem for which they are responsible.

Applied research is a practical tool. It is of no material value unless those who are responsible for it have a clear understanding and conception of the problems to be met and determined by practical means, the efficiency and economy and the adaptability of the commodities offered to solve those practical problems.

Those engaged in applied research have the advantage of those engaged in all other types of research, because those people have developed certain techniques, certain skills, certain instruments and certain experience which become assets to the men engaged in applied research. And the one that is engaged in applied research must not overlook the opportunity to apply, in a practical way, to the solution of specific problems, the skill, experience, the procedures, and the instruments which may have been developed either in the realm of fundamental or creative research. In so using those, always keep that control required to assure the practical timeliness of the results obtained.

The question of light materials or the use of lighter materials and alloys is one that needs further serious study and investigation. Because of the operating conditions that are confronting us today we also have to design with more specificness as to the character of the work that is to be done by the motive power than we have designed heretofore.

In making comparisons between the steam locomotive and other types of motive power, those comparisons should be based upon the latest and most improved steam locomotive. It is unfair and misleading to do otherwise than that. In some locations some of the oldest steam locomotives have been taken as the unit of comparison with some of the latest developments in other lines, and this is not only true with respect to motive power as a whole, but it is also true with respect to many other phases of railway equipment. Therefore, do not be misled by accepting comparisons of something brand new and recently developed, with something that has been in existence for many years, when there is in existence something newer and better in the way of steam power.

Another word that Dr. Winterrowd used several times was "relationship." In many of the problems that have confronted us over the years we have not borne the relationships in mind. For example, we have not borne in mind the relationship between track structures and the motive power that operates over those structures. The relationship referred to in the paper was that between grate area, firebox volume, and firebox heating surface and related matters. I corroborate the author's opinion that there is need for continuing the operation of locomotive test plants. A thorough study should be undertaken promptly that will ultimately result in a revision of the so-called Cole's ratios, which revision would re-establish in the light of present designs and operations the relationships referred to by Dr. Winterrowd. As we understand at the moment, we have no very efficient knowledge with which to compare the relative performance of various types of modern locomotives.

So far as pulverized fuel is concerned, may I suggest that we should not consider the use of pulverized coal as a closed issue simply because the mode tried out a few years ago apparently was unsuccessful. We should not consider anything as a closed issue that was tried out several years ago and found unsuccessful.

I am not as pessimistic as Dr. Winterrowd about the development of successful condensing locomotives. Some developments

in that direction within the last year lead me to say that I believe that successful condensing locomotives are in the realm of possibility.

I am regretful that the author did not directly refer to the potentialities of turbine locomotives, two or more of which are under construction at the present time. Over a year and a half, the Division of Equipment Research has thoroughly studied the proposed design of a steam turbine locomotive and has not found any bugs in any of them.

R. G. Henley (N. & W.): The efficient combustion of fuel and utilization of the hot gases for converting water into steam, as well as the superheating of the steam to the highest temperature practicable, has always been the objective of locomotive designers and producers. Since the maximum demand for locomotive operation at high speeds is for steam in adequate quantities, the boiler design has been of first consideration. In order to produce boilers of required capacity, it frequently becomes necessary to resort to the use of alloy steels to maintain plates of workable thickness and minimize the weight.

The production of alloy steels suitable for boiler construction has been one of the contributions of the metallurgists. Developments in connection with bending and otherwise forming these steels into boilers have revealed that considerably more care and expense is incurred than with carbon steels. The successful utilization of these steels in boiler construction has been principally a contribution of the railroads.

The principles of the poppet valve, as set forth in the paper, have been established. Quick opening and closure of the valves, with a full area of the opened port in the interim between opening and closing, is a requisite for producing increased expansion and mean effective pressure. One of the principal developments which confronts us in connection with the operation of these valves on locomotives is the production of an efficient and dependable driving and control mechanism for the valves.

In connection with driving axle and track loads, although some reduction in track loads has resulted from the use of alloy steels and light sections in the reciprocating parts of locomotives, much is yet to be done to bring these parts to minimum weight without materially increasing maintenance costs. When this is accomplished, the amount of unbalanced weight which must be added to the counterbalance can be minimized and the track, as well as the locomotive, will be the beneficiary, especially in high-speed operation.

Too much cannot be said relative to the reduction of the number of parts and the decreasing of the cost of maintenance of locomotives. There is always an expense to locomotive users attendant upon testing and setting up the necessary organization for maintaining new devices. It frequently happens that new materials requiring different methods of maintenance are introduced, which necessitates that maintenance forces be instructed and followed to see that these new methods are observed to prevent damage or failure in service of these parts from improper handling. This may sound quite simple, and would be so were only one or a few items of such equipment involved, but in this day

of rapid development and testing of so many new devices, the utmost caution should be exercised by designers and manufacturers to have as few parts as possible and these of materials which require the least special attention in manufacture and maintenance. If this is not done, the maintenance cost is liable to become prohibitive.

Among other devices the paper advocates the use of auxiliary power as a means for increasing the effectiveness and maximum capacity of the locomotive. Although this may be worth while, the fact should not be overlooked that the equipment for this auxiliary power will necessarily carry with it additional weight to be transported and additional maintenance problems to be dealt with.

It is noted that the paper does not mention bed castings with the frame, cylinders and cross-ties cast integral, and the roller-bearing. Two cast-steel bed castings on a mallet locomotive displace in the neighborhood of a total of 700 major and minor parts. Since these bed castings have been developed to a point where failure is infrequent, the cost of maintenance has been materially lowered.

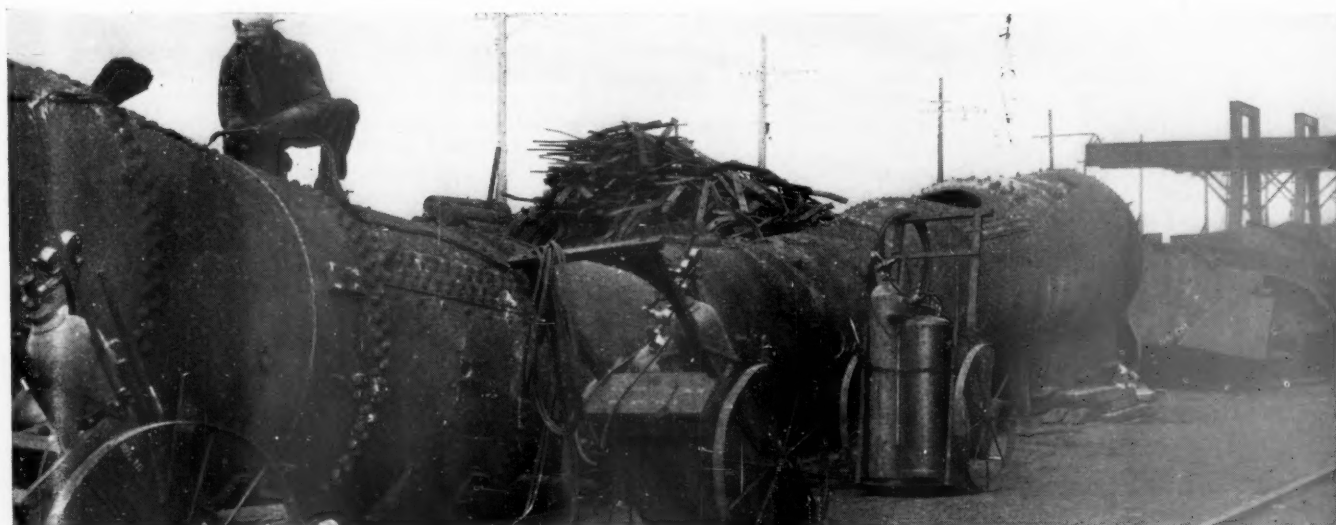
The elimination of the maintenance of the conventional type of driving boxes and other parts, through application of the roller bearing to the driving wheels of locomotives, has resulted in a substantial increase in availability.

H. Rubinkoenig (Purdue University): Some 35 years ago Dr. Goss made a statement that any improvement in the performance of a locomotive or the adoption of any economy device can be utilized in two ways: First, to extend the power of the locomotive with the same fuel consumption, or second, to utilize the same amount of fuel and get a reduction in the fuel consumption. Dr. Winterrowd has touched upon a number of features in this paper that should accomplish those results among which was condensing. Condensing does not necessarily apply to the turbine locomotive but possibly to the reciprocating locomotive, where there is preheating of combustion air. If we can expand the steam down to atmospheric pressure by the use of air condensers instead of having to release the steam to 25 to 50 lb. exhaust release pressure, necessarily it will result in a considerable increase in the amount of work obtained from one pound of steam.

A report on a uniflow locomotive, prepared by the Railway Fuel Association three or four years ago showed a steam economy of 11 lb. per b. hp.-hr. If we can assume a mechanical efficiency of 9 per cent, that will reduce the steam consumption per indicated horsepower to slightly less than 10 lb. Compare this with the steam consumption of 18½ lb. per i. hp.-hr., now being obtained with the locomotives you are now designing.

W. H. Winterrowd: I would like to emphasize the importance of co-operative effort in locomotive design, which was discussed by Mr. Ellis, if the locomotive is to net a maximum return to the railroads. Mr. Ellis' point in connection with research regarding higher piston speeds is well taken. I think that research in that direction is highly desirable.

Mr. Henley suggested that the application of supplementary



Getting Ready for New Power

power may add additional weight to the locomotive and it may add to its cost of maintenance. The locomotive of the future must be looked at as a whole and a considerable net reduction in the total weight of the locomotive, with an increase in power, can be accomplished. It may be necessary to add somewhat to the complication of the locomotive, the cost of maintenance may be

slightly more, but the proper place to look for the answer in connection with the locomotive is in the net return to the railroad. Any design that will make such a return to the railroad needs no further commendation.

(On motion, Mr. Winterrowd was accorded a rising vote of thanks.)

## Report of Committee on Locomotive Construction

Twelve subjects covered—Locomotive Tire Manual is presented—

First report on the fusion-welded locomotive boiler



W. I. Cantley  
Chairman

### Driving Wheel Centers of Thin-Wall Section

With its reports for each of the years 1934, 1935 and 1936, the committee included a statement of railroads which had applied driving wheel centers of the various thin-wall section types and gave other information as to diameter of wheels, types of locomotives, etc., on which these wheel centers were in use. A similar statement, bringing the information up to date as of March 1, 1937, is submitted with this report with a column added to show the change in status of applications from the last report. The

statement includes information given by both manufacturers and railroads and covers new locomotives under construction as well as applications to existing power.

[The table shown here is a summary of the data tabulated in the report, which shows the installations by railroads, locomotive types and driving-wheel diameters.—Editor.]

There were no reports of wheel centers of these special designs having been taken out of service, except voluntary replacement by manufacturers. One new design of disc type wheel center, offered by Baldwin Locomotive Works, has appeared since the last report and is included in this year's tabulation. The Baldwin Locomotive Works reports having made 164 wheels of this design, but only a comparatively small number have been reported by the railroads as applied. In addition, there are other locomotives under construction which are to receive this type of wheel.

All railroads who have had experience with the special wheels for any length of time report their performance as being generally satisfactory although difficulties have been reported in a few cases. The prevailing opinion among roads using wheel centers of these special types is that they are superior to the conventional spoke type. Of the 35 railroads answering the questionnaire, 11 regard disc or box type wheels as being still in the development stage, but 13 definitely regard one or more of these special wheel designs as having outgrown the experimental stage. Thirteen roads report decision to proceed with further installations of box or disc type wheels.

Defects which have developed in driving-wheel centers of the disc and box types have been reported by six different railroads. The character of defects and number of wheel centers affected are 4 cracked in hubs; 9 cracks originating in openings cored through inner and outer plates; 6 cracked between hub and counterweight, and 2 not given. The latter eight were replaced by manufacturers.

All of the above wheel centers which were retained in service are said to have been successfully repaired by fusion-welding, after which they have given no further trouble. The following statements by individual railroads describe difficulties, other than those listed above, which have been experienced with wheel centers of the special designs:

*Railroad A*—"On some special driving-wheel centers, the welds broke loose around ends of tubes which are welded to outer surface of disc plate on each side of wheel. No cracks were found in wheel center castings and tubes were rewelded. This is not

considered a serious defect. Welding methods have been improved on later designs."

*Railroad B*—"In the early design of double disc driving wheel center, when counterbalance requirement placed face of counterbalance outside of the face of the hub, the counterbalance face was subject to eccentric loading. We have had a few cases of radial cracks developing which were radial and not in the direction crack would be expected to develop from eccentric loading. These cracks have been welded and without further trouble. Later design provides an intermediate plate to take the load, entirely relieving the outer face of the counterbalance."

In view of the tendency of spoke-type driving-wheel centers toward lateral distortion under tire shrinkage and flattening of rims over the long spokes, your committee has tried to ascertain as early as possible how wheel centers of the various special designs would withstand these conditions. Five of the roads contacted now report having had occasion to check driving-wheel centers of the box or disc types for rotundity after at least one period of tire wear. Of these five roads, three report finding wheel centers round and with rims in good condition. One states that one main wheel center of a 2-10-2 type locomotive was found to be  $\frac{1}{32}$  in. out-of-round after two years of service. The other road reports as follows:

"On one engine the amount of lateral distortion in the rim of the wheel was determined when the wheels were purchased and before being placed in service. This distortion was determined by means of a special gage which to all practical purposes could be described as a straight-edge across the axle, the purpose of which was to measure from this straight-edge to the rim of the wheel at six different positions around the circumference. Succeeding measurements to determine the lateral distortion were taken at same location with the same gage. The maximum amount of lateral distortion and direction of same since the first measurements were taken and after making 187,000 miles in passenger service are as follows:

	No. 1 Wheel	No. 2 Wheel	No. 3 Wheel
Right	.188 inward	.154 inward	.091 outward
Left	.054 inward	.090 inward	.116 outward

The advantages which have been claimed for driving wheel centers of the various box and disc types are: (a) reduced weight; (b) improved counterbalance; (c) greater strength; (d) better support for tires.

The advantages of reduced weight and improved counterbalance appear to have been fully realized on a number of roads which report marked improvement in riding qualities of loco-

### Installation of Driving-Wheel Centers As of March 1, 1937

	No. locos	No. wheels			Increase over 1936 report
		Main	Others	Total	
Boxpok	519	1,182	1,764	2,946	2,146
Scullin	207	432	186	618	302
Baldwin	78	210	370	580	580
Birdsboro	11	22	0	22	18
Univan	1	2	0	12	0
Duquesne	6	12	0	50	34
L.F.M.	12	24	26		

motives, particularly low-wheeled locomotives to which special types of wheel centers have been applied in replacement of original spoke type wheels. Marked reduction in calculated dynamic augment has also been reported for these locomotives. At present, it appears that the claims of increased strength and improved tire

support have been substantiated to a large extent, but the ideal has not, as yet, been reached in either of these respects.

### Light-Weight Pistons

The general trend in light-weight piston design is toward an arrangement in which the packing rings perform the dual function of carrying the weight of the piston and forming a steam seal around its circumference. The data which appear in the table accompanying this report apply to pistons of this type. The replies indicate that most of the roads using such pistons are extending their use, although two railroads report having fewer locomotives equipped with combination bull-ring packing as of March 1, 1937, than they had on the same date last year. In explanation of this, one of the roads says that the pistons of this type on nine 4-6-4 type locomotives have been so unsatisfactory that they are all being removed.

The replies this year show that bronze is increasing in favor over cast iron as a material from which to make sectional spring-expanded packing rings for light-weight pistons. Rings composed one-half of bronze segments and the other half of cast-iron segments are being advocated by one of the manufacturers but none of the roads answering the questionnaire reported the use of such rings.

The New York Central reports that the locomotive equipped with the Timken rolled-steel light-weight pistons, and bronze packing rings have given very satisfactory service for approximately 90,000 miles up to the time of the report.

The Canadian National reports an increase of 34 in the number of locomotives equipped with light-weight pistons in which the packing rings do not carry the weight of the piston, which was described in last year's report, bringing the total number of locomotives equipped up to 656.

Several eastern railroads, including the Boston & Maine, Chesapeake & Ohio, and Lehigh Valley, report installations of special light-weight pistons in which the conventional bull ring and conical piston head have been combined in an integral casting of gun iron. Packing rings used with these special pistons are of a special sectional design, the segments of which are forced outward in contact with the cylinder walls by hoop-like flat springs.

In its questionnaire for this year, the committee undertook to develop information with regard to light-weight piston valves. The replies indicate that there is but little interest in this subject.

### Firebox Supports and Waist Sheets

In 1927, a Sub-Committee reported on the subject "Provisions for Expansion of Locomotive Boilers on the Frames, Also Firebox Supports." In its report in 1927, the sub-committee illustrated and described a very large variety of guide braces, waist sheets, furnace bearers and the like, but expressed no definite opinions regarding them, nor were any recommendations made.

At the recent suggestion of one or more of the members, the present committee is reconsidering this subject with the idea of making definite recommendations which can be adequately supported by facts and experience. For its guidance in formulating such recommendations to be presented at a later meeting of the Association, the committee desires and urges a frank and thorough discussion of the subject at this time. We wish particularly to know the views of the members on the following questions:

It is obvious that the boiler must be carried upon the frames, but insofar as the boiler alone is concerned, two supports, one at smoke box and another at the firebox, would suffice. Yet practically every locomotive has more than these two structural connections between its boiler and frames. Why are these additional connections applied? Since the boiler needs support at only two points, it may be inferred that all other connections serve merely to make the boiler support or reinforce the frames. If so, have the additional connections, such as guide braces, valve-gear braces, waist sheets, furnace bearers, etc., been in all cases correctly designed and properly applied to do what is expected of them? Should they or should they not be rigidly fastened to the boiler?

Guide braces are intended to reinforce the frames against the vertical reactions of the main rods and crossheads but is this reinforcement fully and completely accomplished if the upper ends of the guide braces merely bear against the boiler and are not

fastened to it? This is not an uncommon construction. The same question applies to valve-gear braces.

The functions and purposes of waist-sheet connections, as applied, are not always clear. In order to withstand flexing due to longitudinal expansion of the boiler, these connections generally include as their principal member a relatively thin plate of considerable height. Such a plate makes a good tension member, but is not well adapted to compression loading. The value of waist-sheets as struts to stiffen the frames against upward reactions produced by equalizers and driver brakes is therefore somewhat doubtful, and their value as tension members to reinforce the frames downward reactions from the same or other causes, such as bending stresses set up when the locomotive is lifted by its ends, seems to be completely lost if the waist sheets are not fastened to the boiler.

It may be that waist sheets were of real service in bracing the light bar frames of old time locomotives against lateral as well as vertical forces, but are waist sheets needed at all in connection with the thoroughly cross-braced frames or one-piece bed of a well designed modern locomotive? This question may also apply to guide or valve gear braces to boilers. Is it not feasible and desirable to design frames or beds which have within themselves sufficient strength to withstand all normal service stresses without reinforcement from the boiler? These conditions have been practically realized in the frames of the front unit on an articulated locomotive. Why should we not design the frames of simple locomotives on the same basis?

For such connections between frames and barrel of boiler as must be used, the committee recommends that the boiler shall be shod or reinforced by the application of outside patches at each brace waist sheet location, the purpose of these reinforcing patches being to protect the shell plates against wear and cracking which commonly result when waist sheets and other braces bear directly against the boiler shell.

The apparent purpose of furnace bearers is to support the firebox end of the boiler and restrain it against lateral as well as vertical displacement while allowing freedom for longitudinal expansion. As a rule, furnace bearers at the front of the firebox function in this manner but is this true of furnace bearers at the rear of the firebox? Is there not evidence that under certain not abnormal conditions rear furnace bearers act as tension members holding up the rear deck and rear portion of the frames? Assuming this to be true, are the rear furnace bearers in common use, particularly those of the sliding type, properly designed to act as tension members?

Are furnace bearers of the plate type well adapted for use at either front or rear of firebox? When bearers of the sliding type are used, it is of the utmost importance to prevent sticking. This calls for correct answers to the following questions: What materials should be used in furnace-bearer construction? Can satisfactory results be obtained with one steel surface bearing against or sliding upon another? If not, should one or both of the contacting surfaces be shod with (a) bronze, or (b) hardened steel, or (c) any other material? What bearing pressure per square inch can we allow for the different materials when so used? Should the sliding surfaces be lubricated? If so, what lubricant should be used and how should it be applied? How can ashes, track dirt, etc., be successfully excluded from furnace bearers?

You can help us by giving us the benefit of your experience and opinions in discussion now and by further study and investigation of conditions upon your own locomotives after you leave this convention. We expect, later on, to circulate a questionnaire in which you will be asked to give us the benefit of your study and investigation.

The reports on the three preceding subjects are each signed by the Sub-Committee on Design of Fundamental Parts of Locomotives, consisting of H. H. Lanning (*Chairman*), G. McCormick, C. Harter, J. B. Blackburn and G. F. Endicott.

### Roller Bearings for Locomotives and Tenders

This report covers steam and electric locomotives but does not include Diesel Electric Locomotives and high speed streamline trains. Replies to questionnaire were received from 124 roads, 90 of which reported no applications, 34 roads reported applications, also reported on roller bearings that were applied prior to December 1, 1935.

From the analysis of reports it is evident that progress has

been made during the past year in extending the use of roller bearings to engine-truck, drivers, trailing-truck and tender-truck axles. New applications for year ending December 1, 1936, are:

Locomotive engine truck .....	56
Locomotive drivers .....	12
Locomotive trailer truck .....	36
Tender truck .....	39

From the reports as of December 1, 1936, there are in service the following locomotives and tenders equipped with roller bearings:

Locomotive engine truck .....	626
Locomotive drivers .....	234
Locomotive trailer truck .....	153
Tender truck .....	577

Roller-bearing failures during the past year were comparatively low and consisted chiefly of broken cages, worn and shelled rollers and races and cracked rollers. A complete report of all failures cannot be made because of insufficient data submitted with the reports. However, the data in the table below was submitted by one large user of roller bearings who gave a complete report on locomotive engine truck and tenders so equipped as of November 30, 1936.

#### One Railroad's Roller-Bearing Service

##### ENGINE-TRUCK AXLES

Total number of locomotives equipped .....	230
Total locomotive mileage .....	129,981,077
Average locomotive mileage per road failure .....	25,996,215
Average locomotive mileage per defective bearing found by inspection .....	698,823
Average locomotive mileage per failed and defective bearing .....	680,529
Average miles of failed and defective bearings .....	286,513
Road failure per 50,000 miles .....	.001923

##### TENDER AXLES

Number of tenders equipped .....	209
Total tender mileage .....	23,498,027
Average tender miles per road failure .....	7,832,676
Average tender miles per failed and defective bearings .....	939,921
Average miles of failed bearings .....	113,833
Average miles of defective bearings .....	204,107
Average miles of failed and defective bearings .....	193,691

Only one road reported failure of driving-axle equipped with roller bearings. This failure was reported as caused by a broken axle at the inside of the roller-bearing fit. The mileage to date of failure was 105,565.

Sufficient reports were not received to determine the total mileage made to date on locomotives equipped with roller bearings on drivers.

No new applications of roller bearings were made to main rods or side rods during the year December 1, 1935, to December 1, 1936. There are, however, reports showing four locomotives equipped, two with main and side-rod bearings on the main pin, and two with bearings in both ends of the main rods and in all side rods. Very few failures were encountered and such failures as did occur are attributed to causes as follows: Lack of lubrication; roller bearing parts fitted too tight; broken cages; rod slipping in crosshead and cracked crosshead. Total mileage made by the four locomotives as of December 1, 1936, was 392,869, an average per locomotive of 98,217 miles.

Eighty-two locomotives have roller bearings on various parts of the valve gear. No failures were reported.

Twenty-eight tenders equipped with auxiliary locomotives boosters, have roller bearings. No failures were reported.

Thirty-five locomotives have roller bearings on booster idler gears. No failures were reported in six months.

Reports from the locomotive builders show that as of February 1, 1937, there are on order or being built 230 locomotives that will receive roller bearings on all or part of the axles as follows:

Locomotive engine truck .....	230
Locomotive drivers—all .....	167
Locomotive drivers—main only .....	10
Locomotive trailer truck, front .....	203
Locomotive trailer truck, back .....	209
Tender truck .....	194

Report from one of the locomotive builders shows that of the locomotives on order as of February 1, 1937, there are

about 75 per cent that will receive roller bearings on all or part of axles for locomotive and tender.

The sub-committee report is signed by, G. F. Endicott (*Chairman*), R. G. Bennett and W. F. Connal.

## Driving and Trailer Tires

### TIRE FAILURES

The Sub-Committee on Driving and Trailer Tires has completed the tabulation of tire failures for the year December 1, 1935, to December 1, 1936. Summary of the failures are shown on two accompanying tables, each covering a period of six months, and also, a summary for the four six-month periods with the information for tire failures that has been collected, sub-divided as between the kinds of failures.

For the first six-month period 54 railroads reported 399 tire failures. For the second six-month period 43 railroads reported 563 tire failures. The major portion of the increase is due to the request of the committee that reports should cover all failures due to shelled tread. In the first six-month period 126 failures were reported due to shelled treads, and in the last six-month period, 340. On account of the uncertainty as to responsibility for shelled treads as between manufacturing processes and service conditions, it was agreed by the committee that these defects should be shown under separate heading. Summary of the tire failures for the two periods follow:

	Manuf'r'g process	Shelled	Unknown and Service conditions	Total
Dec. 1, '35-June 1, '36, 54 roads reporting failures, 34,143 locomotives in service	40	126	233	399
June 1, '36-Dec. 1, '36, 43 roads reporting failures, 34,507 locomotives in service	27	340	186	563

We feel that valuable information has been collected and recommend that the investigation be continued. A questionnaire has been sent out asking for reports of failures for the period December 1, 1936, to June 1, 1937. Illustrations of characteristic types of tire failures were enclosed with this questionnaire to each Railroad, and it is expected that these illustrations will assist materially in the analysis.

### LOCOMOTIVE TIRE MANUAL

A manual has been prepared, which is attached to this report, covering the subject in form similar to the Wheel and Axle Manual. The manual is composed of chapters describing the manufacture of steel tires, and the following pages quoted from the Manual of Standard and Recommended Practices:

M-106-34—Specifications for Tires, Steel, Locomotive and Cars.

F-7-1934—Section of Tire.

F-8-1934—Steel Tires of Locomotive Wheels, Shrinkage Allowances For.

D-53-1924—Tires, Steel, Minimum Thickness For.

It also includes:

Illustrations Showing Characteristic Types of Tire Failures.

Instructions on the Preparation of Wheel Centers and Tires and Application to Wheel Centers.

I. C. C. Limits for Tire Thickness.

Handling, Storage and Shipment of Steel Tires.

[The Manual, which filled 42 pages of the committee report, is omitted from this abstract.—Editor.]

### REVISION OF STANDARDS

Attention is called to the necessity for revising the following sheets in the Manual of Standard and Recommended Practices:

F-7-1934—Section of Tire, Fig. 1, Illustration for Steel Tired Engine, Tender Truck and Trailer Wheels and Flanged Tires of Locomotives, should be changed to conform to the Wheel Tread and Flange for multiple and two-wear wrought-steel wheels on cars and tenders as revised in 1936.

D-53-1924—Tires, Steel, Minimum Thickness For: It is

recommended that the steel tire, bolted type, Fig. 5, be eliminated from standard on account of the design being undesirable. The design of bolted tire reduces the bearing area for the tire on the wheel center, and the holes drilled in the tire for bolting are a source of tire failure, as shown by cracks originating in these holes.

The committee wishes to acknowledge the continued close co-operation of the members of the Tire Manufacturers' Technical Committee. The report of the sub-committee is signed by: R. G. Bennett (*Chairman*), W. I. Cantley and J. E. Ennis.

### An Appraisal of Higher Boiler Pressures

The advantages in the use of higher boiler pressure are obvious and need little comment, within limits. The disadvantages are not so obvious but are present in varying degree and require changes in design and in handling the boilers in order to assure satisfactory operation.

Following is a summary of reports received from various railroads in connections with this subject:

#### CANADIAN NATIONAL

The Canadian National has the following high-pressure engines in service: 80 carrying 250 lb., 6 engines carrying 265 lb., and 28 engines carrying 275 lb. boiler pressure.

These engines are all equipped with Type E superheaters, and owing to the higher steam capacity, produce more work and make more mileage per month than the lower-pressure engines. They are practically all used in service where they run over from two to six divisions.

While the cost of maintenance is no lower—and in some cases is higher than that of lower pressure engines—more efficiency and greater mileage per month is obtained than with the lower pressure engines. The same amount of work can be done with a smaller number of engines because the high pressure engines can be kept in service for a greater number of hours each day.

Five 4-6-4 type locomotives, carrying 275 lb. pressure, in passenger service over a period of six years have averaged 8,000 miles per month, including all time out for repairs, wash-outs, etc.

#### CHICAGO & NORTH WESTERN

Based on the experience of this road with 4-8-2 type locomotives with 275 lb. steam pressure, the increased maintenance problems are as much the result of increased speed as of increased steam pressure. The higher superheat temperatures possible with the higher pressures have added a lubrication problem.

There is also some increase in the cost resulting from the necessarily heavier sheets and greater bracing required with the increased boiler pressures. There are also increased packing problems both in valves and cylinders, as well as piston-rod packing, valve-rod packing, and cab-cock packing, which are being met by improved products.

Increased pressure up to 300 lb. are not believed to introduce increase maintenance problems which are not more than offset by the ability to deliver a greater amount of work. There would be any practical advantage under present operating requirements to go to pressure higher than 300 lbs.

#### GREAT NORTHERN

On the Great Northern the highest boiler pressure is 250 lb.

A number of Mallet engines with 240 lb. pressure have been in service about ten years and nothing has been found out of the ordinary with these engines. A few 2-8-2 and 4-8-4 engines carry 250 lb. pressure.

#### LEHIGH VALLEY

A very careful check of the boiler work on locomotives with pressures from 250 lb. to 275 lb., which have previously been reported. To date it has cost practically nothing to maintain them. Outside of one firebox showing cracks in the vicinity of a few staybolts, which afterwards developed was aggravated by a

slight lamination of the sheet, no boiler repairs have been made and very few replacements of staybolts.

#### NEW YORK, NEW HAVEN & HARTFORD

On the New York, New Haven & Hartford 10 new passenger locomotives were placed in service during March and April of this year, which carry a boiler pressure of 285 lb. No increase in boiler maintenance is anticipated by reason of this pressure, and an appreciable reduction in the weight of the reciprocating parts was secured by reason of the smaller cylinder that can be used with the increased boiler pressure.

#### UNION PACIFIC

The Union Pacific has not operated high pressure boilers a sufficient length of time to determine to what extent the maintenance cost will be affected. However, the fact has been established that the higher the boiler pressure the more these boilers will have to be washed and more care exercised keeping small defects under control, such as staybolt, seam and firebox leakage. It is this road's conclusion that maintenance cost of high-pressure boilers can only be controlled and kept down to compare favorably with low-pressure boilers by—

(1) *Proper Design*—This includes wider water space and increased circulation around the firebox, careful staybolt spacing, and proper thickness of plates.

(2) *Terminal Handling*—High-pressure boilers cannot be maintained with the same handling as afforded low pressure boilers. More care must be exercised in blowing down or cooling boilers, washing and filling up. Special care must be used in maintaining proper terminal water temperatures.

(3) *Keeping High Pressure Boilers Clean*—They must be washed thoroughly and frequently. This is most important.

#### WABASH

Of 50 heavy freight locomotives that have been in service since 1930, 25 carry 245 lb., and 25 carry 250 lb. Thus far nothing has developed to indicate that there is any higher maintenance due to the higher boiler pressure than on engines carrying 200 lb. boiler pressure.

#### THE ATCHISON, TOPEKA & SANTA FE

There are under construction for the Santa Fe 17 new locomotives for passenger service which will carry 300 lb. working pressure, and 10 locomotives for freight service, which will carry 310 lb. working pressure. All of these locomotives will have radial-stay boilers with nickel-steel shells. In 1927 a group of 15 locomotives were placed in service with boilers designed to carry 275 lb. working pressure. This has been carried on only six of the locomotives, the others being operated at 220 lb. Decision has now been made whereby all locomotives of this group will carry 275 lb. working pressure.

#### BESSEMER & LAKE ERIE

The maintenance of locomotives carrying 250 lb. pressure is apparently no greater than with lower pressures.

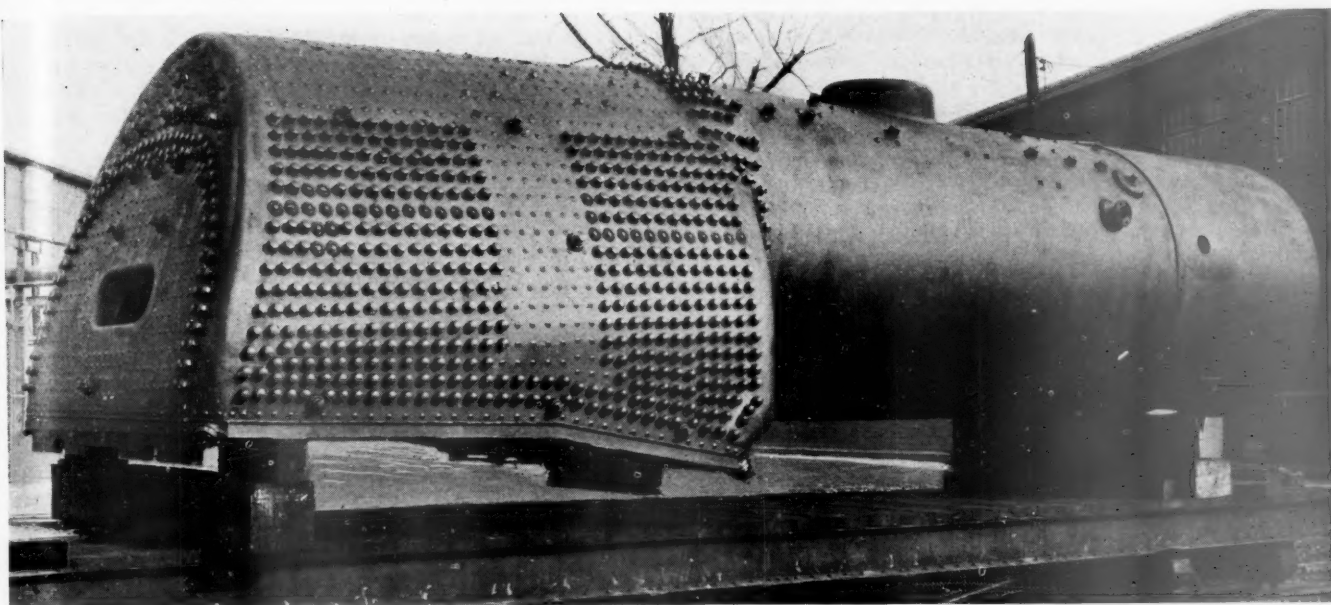
The efficiency of the locomotives with 250 lb. pressure is much improved over lower-pressure locomotives. The 250-lb. locomotives are of later design and equipped with modern appliances, so the increased efficiency cannot be allocated to the higher pressures alone.

#### CHESAPEAKE & OHIO, NEW YORK, CHICAGO & ST. LOUIS, PERE MARQUETTE

The maximum boiler pressure on present locomotives is 270 lb. on one locomotive, 265 lb. on 39, 250 lb. on five and 245 lb. on 15 locomotives. Fifteen additional freight locomotives designed for 250 lb. pressure are under construction.

To date no unusual maintenance attributable to the higher





Delaware & Hudson Locomotive Boiler Built By Fusion-Welding Process

ous reports, the tendency still appears to be to confine the greater percentage of these units to switching service, 90 per cent of the total ownership being so employed; however, during the past two years, probably due to units of greater horsepower available, this type of power is being successfully adapted to transfer service and at least in some cases in combination switch and transfer service. The application of the use of this type of power to main-line freight trains to date has been nominal, although at least one road reports that it has two units in excess of 1000 hp. each which are used singly in road passenger and in combination in road freight service. The use of Diesel locomotives in road passenger service is on the upward trend, especially with units of 900 hp. and over.

Comparatively recent application of Diesel power to rail transportation has been to articulated, generally light-weight, and invariably streamlined trains and, while these trains are dependent upon Diesel engines for their power, they are not in the strict sense of the word Diesel locomotives and were not included in Table I. These trains have had a marked appeal to public fancy and are so well known that they have been tabulated in Table III (omitted here) under their familiar names.

No comparisons of operation costs have been made due to the fact that any comparison of the number of units involved would be of such general nature as to be of little value, since the requirements of service and the particular conditions under which the unit is to be operated are still the governing factors in the use of this type of equipment and each installation presents a more or less distinct study.

The reports cover a 12 year period and there are no records available of Diesel powered locomotives which have been retired after having been placed in successful operation. There have been some few experimental units built which did not reach the stage of successful operation and in fact have not been considered for the purpose of this report.

The report of the sub-committee is signed by H. P. Allstrand (*chairman*), W. F. Connal, and W. I. Cantley.

#### Globe and Angle Valve for 300-Lb. Pressure

During the past year it has developed that there is a considerable demand for valves of the outside-screw type in sizes  $\frac{1}{2}$ -in.,  $\frac{3}{4}$ -in. and 2-in., which had not heretofore been included in the manual. To meet this demand, the committee has had designs prepared for these sizes as shown on revised pages F-146, 147, 156, 157, 160, 161, 172 and 173, which are now submitted for Recommended Practice. Parts of the valves not covered by the pages above mentioned are identical in design and dimensions with valves of the inside-screw type for corresponding sizes.

The committee is also giving consideration to the matter of providing designs for globe and angle valves for superheated

steam up to 400 lb. pressure and a temperature of 750 deg. F. and it is expected that these designs will be ready for submission prior to the next annual meeting.

Some of the valve manufacturers have raised the question as to providing hand wheels in strict accordance with the dimensions specified in the manual and it is recommended that hand wheels may be the various manufacturers' standards provided they properly fit the stem of the standard valves.

#### Screwed Pipe Fittings for 300-Lb. Pressure

On the recommendation of the Manufacturers' Standardization Society of the Valve and Fittings Industry and the approval of the Locomotive Construction Committee, it is proposed that the following paragraph be printed on Pages L-133 and L-137 of the Manual:

"Reducing sizes of fittings for which dimensions are not given in the tables may be produced from regular patterns for listed sizes by sand bushing."

This and the report on the preceding subject were signed by the following sub-committee: J. E. Ennis (*chairman*), W. I. Cantley and R. G. Bennett.

#### Building Locomotive Boilers by the Fusion Welding Process

At a meeting of the General Committee of the Mechanical Division, Association of American Railroads, held June 25, 1935, there was some discussion of suggestion by one of the member roads relative to construction of locomotive boilers by the fusion welding process. The action at that meeting was that the Committee on Locomotive Construction be instructed to consult with representatives of the locomotive builders and start a preliminary investigation covering the basis of procedure, and also to include in its study the matter of such tests and research as should be conducted and an estimate of cost.

On October 11, 1935, this committee received a letter from G. S. Edmonds, superintendent motive power, Delaware & Hudson, in which he stated they had for some four and one-half years, in collaboration with the American Locomotive Company, been carefully studying and investigating, both by experiment and research, the development of a welded conventional locomotive boiler.

In view of the fact that the Delaware & Hudson contemplated building such a boiler, it was our opinion that, if agreeable to them, we should join our forces and work out the problem together, bringing in the locomotive builders and representatives of the various welding societies.

This arrangement was satisfactory to the Delaware & Hudson

and the committee suggested to Mr. Edmonds that he prepare his data and drawings of the boiler and we would arrange for a meeting to discuss the design with him. This meeting was held on Jan. 3, 1936, and, in addition to the sub-committee on Locomotive Construction, the following were present:

G. S. Edmonds, superintendent motive power, D. & H.; Dr. C. A. Adams, professor of electrical engineering, Harvard University; J. Partington, American Locomotive Company, who is chairman of the Welding Committee of the A. S. M. E.; W. E. Woodard, vice-president, Lima Locomotive Works; J. G. Blunt, chief mechanical engineer, American Locomotive Company, and R. S. McConnell, mechanical engineer, Baldwin Locomotive Works.

At the meeting the entire design was gone over and suggestions were considered as to how some of the details of design in connection with the welding could be improved upon. When the design was completed, the final drawings were given the approval of all the members who attended the meeting.

Mr. Edmonds then presented the design to Hall, chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, and made a formal request for permission to proceed with construction of the boiler in question. He gave his permission, provided the design of the boiler, specifications and material met the approval of the Committee on Locomotive Construction and also the General Committee. This was all passed upon and approved, and the American Locomotive Company proceeded with the construction of the boiler. The boiler was built at the Dunkirk, N. Y., plant of the locomotive company, all welding being very carefully supervised and X-rayed. Upon completion, it was sent to Nashville, Tenn., to be stress-relieved, and then returned to the American Locomotive Company for installation of the firebox and final completion. Hydrostatic and hammer tests were made on March 18, 1937, at the Schenectady, N. Y., plant of the American Locomotive Company. The boiler has now been delivered and the Delaware & Hudson is making the necessary preparations for applying it to a locomotive.

After the boiler has been applied to a Delaware & Hudson locomotive it is proposed to use it as a stationary boiler for a period of a month or six weeks for observation and check, after which it will be placed in regular service. During the first year the jacket and lagging will be removed and examination made each three months; in the second year, each six months, and yearly thereafter for a period of five years.

The sub-committee of the Committee on Locomotive Construction will continue to follow up this boiler after it has been placed in service and will furnish reports and information from time to time that may be of interest to the Association of American Railroads.

The report of the sub-committee is signed by W. I. Cantley (Chairman), R. G. Bennett, J. E. Ennis, H. P. Allstrand, J. B. Blackburn, G. H. Emerson, and W. F. Connal.

### Locomotive Guiding

The following factors must be considered in providing the proper guiding properties in locomotives: resistance in engine truck, length of driving-wheel base, lateral play of driving axles, and resistance of trailing truck.

An examination of the records of the locomotives built during several years past shows that with very few exceptions all new locomotives have used the so-called constant-resistance type of engine and trailing trucks.

For locomotive with four-wheel trailer trucks the resistances used have been: engine truck, 30 to 35 per cent initial and constant; trailer truck, 15 per cent initial and constant, with a few applications having 15 per cent initial and 10 per cent constant.

For locomotives built in the past with two-wheel trailer trucks the resistance was: engine truck, 40 per cent initial and constant or 40 per cent initial and 33 1-3 per cent constant; trailer truck, 20 per cent.

The resistance of the engine-truck bolster to lateral motion is expressed in percentage of the weight upon the bolster; i. e., an engine truck having 33 1-3 per cent constant resistance has a resistance to lateral motion of 33 1-3 per cent of the weight carried upon the center plate, and this same relation between lateral resistance and weight upon the center plate continues for the entire motion of the bolster.

In the case of trailer trucks, the resistance device which centers the trucks and provides stability to the locomotive superstructure is generally placed to the rear of the trailer axle or axles. The resistance to lateral motion is expressed in the same general way as for engine trucks; i. e., the resistance to lateral motion is a percentage of the weight upon the rockers. The resistance stated is at the rockers. For obtaining the reaction at the trailer wheels the leverage due to rocker position must be considered. With heavy locomotives having long-driving wheel bases there has been a tendency to reduce these values.

Most of the locomotives to which these trucks were applied have had driving axles with plain bearings, and with the lateral play usual with this type of bearing. In the case of locomotives having long driving-wheel bases, lateral-motion driving boxes were used on No. 1 driving wheel and occasionally on the last driver.

Recently it has been necessary to consider certain new factors, such as increased speed of operation, anti-friction bearings with fixed lateral play, and longer locomotives. A consideration of these factors has led to research upon this subject by one of the locomotive builders and there follows a statement giving the results of each study, together with this builder's recently adopted practice. This is submitted not for recommended practice but rather to provide the most recently developed data upon this subject.

[For the results of this study see the *Railway Age* of January 16, 1937, page 155.—EDITOR.]

The adopted practice of the builder referred to is:

(1) Set all tires of the locomotive, both truck and drivers, 53½ in. apart for standard gage track, using lateral resistance mechanisms to obtain necessary wheel-flange clearance.

(2) Provide lateral moving mechanisms such as to equalize, if possible, all wheel flanges of the locomotive against the rail on curves.

(3) All lateral-motion mechanisms should be of an increasing resistance self-centering type.

(4) Unflanged tires or closed-in tire setting should not be used.

The Builders' Committee is co-operating with the Locomotive Construction Sub-Committee in connection with two other subjects which are closely related to the foregoing, that is, lateral motion in the front pair of wheels of four-wheel trailing trucks and rail stresses under locomotives, but is not in position at this time to furnish any definite recommendations.

This report on this subject is signed by the Builders Committee, the members of which are: W. E. Woodard, vice-president, Lima Locomotive Corporation (chairman); R. S. McConnell, mechanical engineer, Baldwin Locomotive Works, and J. G. Blunt, chief mechanical engineer, American Locomotive Company. For the sub-committee of the Committee on Locomotive Construction, the report is signed by W. I. Cantley (chairman), C. Harter, H. P. Allstrand, G. McCormick and J. B. Blackburn.

### Failures of Axles and Crank Pins

The sub-committee has prepared a questionnaire to develop information as to failures of locomotive axles and crank pins for the period January 1, 1931, to December 31, 1936, which has been sent to 38 representative railroads. Returns have been received to date from 29 railroads which on December 1, 1936, owned 24,434 locomotives assigned to freight and passenger service, which is 64 per cent of all locomotives owned by railroads in the United States and Canada.

L. W. Wallace, director of equipment research, has offered to prepare the analysis and tabulation of these replies. A preliminary statistical analysis has been made, a brief summary of which follows:

#### DRIVING-AXLE FAILURES

The average mileage before failure was for locomotives in passenger service, 292,000 miles; for locomotives in freight service, 219,000 miles; average of all failures, 239,000 miles.

In freight service, there was one failure a year for every 173 locomotives in service, and in passenger service, one failure a year for every 153 locomotives in service. Main driving axle failures were 90.1 per cent of all axle failures.

The distribution of failures by location on the axle was as follows:

	Percentage of total number of failures
In journal .....	67.0
In wheel fit .....	13.9
Fillet next to wheel fit .....	9.5
Flush with hub face .....	8.1
Between journals .....	1.5

Overheating was the cause of 63.1 per cent of failures at the journals.

The causes of 69.8 per cent of the failures in the wheel fit were reported as unknown.

Poor machining was the cause of 67.0 per cent of the failures at the fillet next to the hub.

The cause of 42.3 per cent of the failures flush with the hub face were reported as unknown.

The machining of square corners in the eccentric keyway was the cause of 50 per cent of the failures between the journals.

### CRANK-PIN FAILURES

The average mileage before failure of crank pins was for locomotives in passenger service, 180,000 miles; locomotives in freight service, 137,000 miles; average of all failures, 151,000 miles.

In freight service there was one failure a year for every 192 locomotives in service. In passenger service there was one failure a year for every 131 locomotives in service. Main crank-pin failures constituted 78.4 per cent of total.

The distribution by location on the crank pin follows:

	Percentage of total number of failures
In wheel fit .....	30.7
Fillet next to wheel fit .....	28.5
Flush with hub face .....	28.6
Side-rod journal .....	6.2
Fillet between main and side-rod journals .....	3.0
Main-rod journal .....	1.1
Eccentric fit .....	1.3
Crank pin loose in wheel center .....	0.6

The causes of 71.4 per cent of the failures in the wheel fit were reported as unknown.

Poor machining was the cause of 51.0 per cent of failures at the fillet next to the hub.

The causes of 61.2 per cent of the failures flush with hub face were reported as unknown.

The causes of 61.1 per cent of the failures in the side rod journal were reported as unknown.

Poor machining was the cause of 72.5 per cent of the failures at fillet between main- and side-rod journals.

Poor material was the cause of 60.0 per cent of failures at main-rod journal.

Poor machining was the cause of 42.9 per cent of failures at the eccentric fit.

All failures due to loose crank pins were reported to be due to a poor fit.

Considerable additional information is to be derived from analysis of the replies to the questionnaire, and this work is being done. It is expected that in the final analysis, sufficient information will be developed to enable the committee to produce some definite recommendations or at least point the way for further research.

The report of the sub-committee is signed by Kenneth Cartwright (*chairman*), H. P. Allstrand and J. B. Blackburn.

### Exhaust-Steam Injectors

During the year 1936 22 locomotives were built that were equipped with exhaust steam injectors, and up to February 1, 1937, the locomotive builders had orders for 64 locomotives that will be equipped with exhaust steam injectors. Five of the locomotives built in 1936 have the turbo type and 14 to be built in 1937 will have the turbo type of injector.

Of the locomotives built in 1936, three carry steam pressure of 245 lb., five 250 lb., five 255 lb., five 260 lb., and four 275 lb. Steam pressures for those now on order to be built during 1937 will be as follows: Ten, 245 lb., ten, 250 lb., four, 260 lb., ten, 285 lb. and twenty, 300 lb.

This report is signed by a sub-committee of which the members are G. F. Endicott (*chairman*) and W. I. Cantley.

### Sizes of Copper Flue Ferrules and Copper Tubing

The sub-committee prepared a questionnaire to which replies have been received from 35 representative railroads comprising 208,931 miles. These replies have been carefully tabulated, and it is found that at present considerable differences exist with respect to sizes of flue ferrules and copper piping used on different roads, as indicated below.

#### FLUE FERRULES

Size of flue	No. of ferrule sizes used
2 -in. and 2 1/4 -in. ....	134
3 -in. and 3 1/2 -in. ....	66
5 3/4 -in. and 5 1/2 -in. ....	51

#### COPPER PIPE

There are thirty-six variations in outside diameter from 1/8-in. iron-pipe size up to 5.268-in. From one to twelve gages are used with the same outside diameter. The total number of variations in size and gage is 152.

The committee feels that the number of sizes both for copper flue ferrules and for copper tubing can be materially reduced. It is also found that it is the practice of some roads to eliminate copper flue ferrules entirely, rolling and welding the flue direct to the sheet.

The work is being continued, and it is expected to be able to submit final report with definite recommendations during the next year.

This subject was reported by Kenneth Cartwright (*chairman*), W. I. Cantley and J. E. Ennis.

The members of the Committee of Locomotive Construction are, W. I. Cantley (*chairman*), mechanical engineer, Lehigh Valley; H. H. Lanning (*vice-chairman*), mechanical engineer, Atchison, Topeka & Santa Fe; R. G. Bennett, general superintendent motive power, Pennsylvania; G. McCormick, general superintendent motive power, Southern Pacific; W. F. Connal, mechanical engineer, Canadian National; G. H. Emerson, chief motive power and equipment, Baltimore & Ohio; G. F. Endicott, mechanical engineer, Northern Pacific; J. E. Ennis, engineer assistant, New York Central; J. B. Blackburn, mechanical assistant to chief mechanical officer, Chesapeake & Ohio; C. Harter, chief mechanical engineer, Missouri Pacific Lines; H. P. Allstrand, principal assistant superintendent motive power and machinery, Chicago & North Western; K. Cartwright, mechanical engineer, New York, New Haven & Hartford.

#### Discussion

(The report was presented by sections, each section being read by the chairman of the sub-committee in charge of its preparation. John Purcell was in the chair.—EDITOR.)

#### THIN WALL SECTION TYPE DRIVING WHEEL CENTERS

D. S. Ellis: As I interpret it, this is more or less of a progress report to familiarize the members with the progress being made in the development of the thin-wall type driving-wheel centers, both from the standpoint of the various types of manufacture as well as applications made from year to year. While the report includes the four principal claims or advantages for this type of wheel center, based on our limited experience we do not feel that we are yet in a position to say definitely one way or another, whether all or part of the advantages claimed have actually resulted. It will be noted that out of a total of 35 railroads answering the questionnaire prepared by the committee, 11 of the roads regard this type of wheel as being still in the development stage, whereas 13 regard it as having outgrown the embryonic stage. Due to the drastic change in the basic idea of driving-wheel construction as incorporated in wheels of the design covered in this report, such as cored hubs, weights, reduction in thickness of hubs, support of rim through side wall, rather than at center of rims, and the possible

effects of heat on the inner and outer walls when applying tires, this subject appears to be one that should be carefully considered and one on which study should be continued and further report made for the coming year by this committee.

H. W. Faus (N. Y. C.): The report calls attention to the fact that on some special driving wheel centers the welds broke loose around ends of tubes which are welded to the outer surface of the plate on each side of wheel. No cracks were found in wheel center castings and tubes were rewelded. This correctly describes some difficulties we experienced. They were not considered serious.

Since that information was supplied to the Committee, however, one of these centers was found with a small crack in the center plate. This crack originated at the sharp edge of a triangular cored hole between the main hub and the crank-pin hub, and progressed by slow growth in detail from  $2\frac{1}{2}$  in. toward the crank-pin hole, which it had not reached when it was discovered and the wheel center removed and scrapped. When broken open it was found that the crack had not extended entirely through the section at any point.

Even this experience has not caused us to lose faith in this type of wheel center, for several reasons: First, this particular wheel center was one of the first locomotive centers of this type applied in 1932, nearly five years ago, and the conclusion has already been reached by the manufacturer, as well as by our railroad, that this first design represented an unnecessarily long step in the direction of weight saving. The weight of one of those centers was only 2,213 lb., as compared with 3,550 lb. for the spoke type of center, which it replaced. Substantially thicker sections of metal were used in later designs. The failed center had given no trouble until after 213,070 miles of service.

On the whole, our experience with the disc and box type of wheel center is such as to convince us that they are definitely superior to the conventional spoke type of center.

Another thing I note in the report is that no distinction is made between carbon-steel and alloy-steel wheel centers. My understanding is that two or three of the types of wheel centers listed are supplied in special alloy steels only, whereas others are furnished in A.A.R. specifications Grade B carbon steel. I am not attempting here to express any opinion favorable or unfavorable to either class of material, but would like to suggest that information of this kind be included in subsequent reports on this subject.

#### LIGHT WEIGHT PISTONS

H. H. Lanning (A. T. & S. F.): Although the answers from the railroads concerning light-weight valves indicate that there is a lack of interest in this subject, the committee is reluctant to believe that such is the case. I hope that some roads represented here today will display some interest in this matter.

D. S. Ellis: This report likewise is one that may be classified as a progress report in order that we may be familiar with what apparently is a general trend in light-weight piston design, looking toward reduced friction and reduction in the weight of this important part. In the light of what may be termed experiments now being conducted with various combinations of metal and integral design of bull rings and piston heads, a study of this subject should be continued by this committee.

C. H. Bilty (C. M. St. P. & P.): We have experimented with some light-weight piston valves with bodies of  $7\frac{1}{2}$ -in. inside diameter pipe with walls  $\frac{1}{4}$ -in. thick and have accomplished from 62 to 70 lb. reduction in the weight of the valves. In that connection, we experienced some difficulty in the higher piston speeds, which sometimes reached 2,000 ft. per min. in high-speed locomotives. With the usual cast-iron piston ring we found considerable wear, sufficient wear to result in making it necessary to replace the packing. We are now using a combination of bronze and cast-iron sectional piston rings, and have been able to increase that service to 60,000 miles.

#### FURNACE AND FIREBOX SUPPORTS

D. S. Ellis: This report forcibly brings out four major questions that every mechanical man should analyze and consider in the future, namely: (1) What is the function of waist sheets; (2) should they be attached rigidly to the boiler; (3) should they support the boiler or the frame; (4) are they necessary with frames which are made integral either by casting or welding.

These four questions present a wide field for study and research, and I seriously recommend at this time, subject to the approval of the chairman, that any of our members who have definitely proved ideas regarding the answers to this question submit them to this committee to help them seek the answer to their problem.

One of the other most important questions developed in this report is the matter of lubricating furnace bearers. I would like to suggest to the committee that they investigate this subject from the point of view of maximum bearing pressure of the furnace-bearer sliding plate, for, based on our experience, this appears to be the limiting feature which decides whether oil or grease should be used as a lubricant for this part.

W. E. Pownall (Wabash): Cracking of boiler shells at the upper edge of the waist-sheet connections have proved very costly. Our first attempt to overcome this condition was the riveting of a liner to the boiler and then riveting the tee or angle at the top of the waist sheet to the liner. Soon the liners cracked instead of the boiler shell. This accomplished something, but the renewal of the cracked liners was also expensive. Incidentally, this transfer of the cracking from the shell to the liner eased our minds of the question of caustic embrittlement. We had been considerably concerned on this question, but this definitely proved a physical strain as causing the cracking of shell and later the liner, rather than caustic embrittlement. We have adopted a construction in which a liner is riveted to the boiler but not connected in any way to the tee or angle. We do not know yet whether this will have any effect on the problem, but we believe we have the right thing.

R. G. Henley: We also have experienced a great deal of trouble because of the cracking of the shell and the liner at waist-sheet connections after the liner was below the boiler shell. About a year ago we built two 2-6-6-4 locomotives and eliminated the waist sheets entirely. The boilers were connected directly to the high-pressure cylinders, and the furnace bearer near the front end of the mud ring. This locomotive has run over 100,000 miles and has given no trouble. It indicates to us that waist sheets are unnecessary. After we have obtained probably two or three times the mileage just mentioned more information may be available for the committee.

H. H. Lanning: Mr. Henley, have you also eliminated braces between the boiler and guides?

Mr. Henley: Yes.

Mr. Lanning: And do these locomotives have a locomotive bed?

Mr. Henley: They have a locomotive bed side casting.

J. M. Hall (Interstate Commerce Commission): In 1911 and 1912 it was the practice of the Southern Pacific to rivet the waist-sheet braces to the belly of the boiler. Invariably that would result in cracks. In connection with the Southern Pacific at that time, we asked them to free the waist-sheet braces from the boiler, let them act as weight carriers, if necessary, and let them slide and not interfere with the expansion of the boilers.

I would like Mr. Powers of the Southern Pacific to state whether or not that entirely corrected the tendency to crack where the waist sheet braces were welded to the boilers.

J. A. Powers (S. P.): I recall the condition referred to by Mr. Hall, and can say that the angle section that he refers to was riveted to the boiler, but shortly after, we discontinued riveting the angles and the trouble ceased. We have had no cracks in that particular place, of any consequence, since we have cut the angles loose.

S. A. Schickedanz (C. & E. I.): On our road at one time we had no liners on boilers and waist sheets were riveted. We had a predominance of cracked boiler shells, guide braces, and intermediate waist sheets, and we applied the liner and riveted the angle to the liner. This helped somewhat. Later we applied the liners and let the angle on the top of the waist sheet loose. On every locomotive that we have at this time, it is not attached to the boiler, only at the cylinders, and at the firebox mud rings, and we have practically eliminated all cracked boiler shells.

I do not think that waist sheets should be left off old frames. We experienced trouble with rough riding on one locomotive. For some time we were unable to locate it. One of our inspectors discovered the angle iron was not bearing directly on the bottom of the boiler. We remedied that, and that has proved that we should not leave the waist sheets off.

W. M. English (Monon): The complete elimination of all waist sheets that are fastened to the boiler from cylinders to fire box would benefit the boiler, and I therefore feel that de-

sign of new power should tend toward incorporation of sufficient frame strength to eliminate safely these sheets or at least keep them free from rigid connection to the boiler shell, provided the total weight of the locomotive is not increased.

On existing larger locomotives the question is: "What can consistently be done without inviting frame breakage or excessive machinery maintenance?" Our limited experience in this matter on our line has only aggravated the question. We have certain Santa Fe, Mikado and Pacific type locomotives, with the waist sheets bearing against the lower circumference of the boiler shell with adequate wearing plates. On the Pacifics and Mikados, the apparent results seem quite satisfactory but, when observing the Santa Fe from the running board while working steam, you can detect a lateral movement of the frames near the guide yoke, also a vertical movement or vibration. However, no bad results have yet developed. I hope the committee has in mind some research work to determine accurately, if possible, whether or not machinery stresses are thus adversely effected or fatigue increased. Such a study will result in findings upon which definite recommendations can be made.

C. H. Bilty: We have experienced the same difficulty where the waist sheets were rigidly attached to the boilers, principally in the connection at the outer ends of the waist sheets, causing cracks to develop in the barrels. In one instance in particular, the boilers on 100 locomotives developed cracks. We cut the waist sheets loose from the boilers by attaching the angle to each side of the  $\frac{5}{8}$ -in. waist sheet, leaving a  $\frac{1}{2}$ -in. wear pad on the barrel of the boiler, with the result that no more cracks developed. On a Mikado-type locomotive we also found a waist type of furnace bearer at both the front and the rear end of the firebox cracking, especially through the cut-outs for the grate-shaker rods. These were replaced with a sliding-shoe type of bearer of dissimilar metals—that is, bronze bearing against hardened steel—and lubricated with soft grease through an Alemite fitting. We find it works very successfully.

I would be rather hesitant in recommending that waste sheets be entirely eliminated, especially on the older engines, due to lateral movements, but I think possibly that the elimination of waist sheets could be accomplished on the strong, heavy construction, especially with the strong backbone of an integral air reservoir.

J. W. Burnett (U. P.): We have been troubled with intermediate waist sheets pulling loose from the frame and boiler of a three-cylinder locomotive which develops 106,000 lb. tractive force. We doubled the strength of the intermediate waist sheet and made a guide of it right in the center. We jacked the boiler from the frame and allowed it to settle down on this guide, letting each intermediate waist sheet carry its weight. Hence there are no solid connections except the cylinder saddle, and the furnace bearers under the firebox. That seems to have corrected our troubles.

#### ROLLER BEARINGS FOR LOCOMOTIVES AND TENDERS

D. S. Ellis: While this report is primarily a progress report covering new applications for the year just ending, there is contained therein a very interesting and illuminating report covering the apparent experience of one of our major railroad systems, which is the first concrete information I have ever seen on the subject and clearly indicates to me the advance being made in applications of roller bearings. This art is apparently outgrowing the embryonic stage and is one deserving of our every consideration in the future developments of steam locomotives. At this point, I should like to acknowledge and give credit, for the interest taken in the general design of locomotives and the part they have played in assisting in the development of the present locomotives, to the roller-bearing manufacturers themselves and the countless dollars they have spent in this development. I particularly note that the report of this committee does not include the type of roller bearing application used by the Norfolk & Western, wherein the driving axle is relieved practically 100 per cent from carrying any part of the static weight of the locomotive itself, and suggest that a representative of the N. & W. tell us of their experience.

Mr. Henley: A little over a year ago we built two experimental locomotives with the roller bearings enclosed in the hub of the driving wheel. A tube supports the inner race, the outer race being supported by the wheel. The axle is practically what we all know as a full-floating axle on an automobile. Unfortunately, we did not provide sufficient clearance between this tube

and the main axle on the first two locomotives. As a result of the deflection of that axle and the tube there resulted a freezing between them on one of the locomotives. We had to get the wrecker out to bring it in. Otherwise we have had absolutely no trouble.

We are now building eight additional locomotives of the same type, but we are increasing the wall thickness of those tubes on the main axle by  $\frac{3}{8}$  in., which we hope will overcome all chances for the tube to follow the axle.

On two experimental engines we have taken the tubes off and bored them out  $\frac{1}{8}$  in., increasing the clearance. We have had one of those crack on account of thin wall thickness.

Those locomotives which I mentioned before are the same ones which have made over 100,000 miles. We have had no trouble with the roller bearings nor any other parts of the assembly.

R. G. Bennett (P. R. R.): We have had quite a lot of experience with roller bearings, having equipped one of our 4-6-2 K-4 engines with Timken bearings on the engine truck, driver, trailer, and the crank pins. The engine has been going satisfactorily. It requires very close maintenance; you have to work almost to thousandths of an inch.

On our electric locomotives, we have roller bearings on practically all axles, except a few engines on which we have been experimenting with friction bearings on the engine trucks. We have had practically no trouble at all with the roller bearings which makes one feel, as far as that installation is concerned, that it has practically passed the experimental stage.

On our steam locomotives we have had roller bearings on the engine trucks of 15 engines, on the trailer trucks of 12 engines, and on about 130 tenders. On these we are having practically no trouble at all.

Mr. Faus: Today the total number of locomotives equipped with roller-bearing engine trucks on the New York Central has been increased from 230 to 262 and if 50 Hudson type locomotives now under construction are included the total becomes 312.

The 50 locomotives now under construction are also being equipped with roller-bearing tenders, drivers and trailer trucks. Also five of these locomotives will be equipped with roller-bearing main and side rods.

The most serious problem with which our railroad has had to contend in connection with roller-bearing applications is that of axle life. Few axles have failed on the road but an exceptional degree of vigilance has been required to avoid such failures and the number of cracked axles found upon inspection and removal has been too large to be viewed with satisfaction. These axle failures cannot be charged to any one type of roller bearing to the exclusion of others.

It has been fairly well demonstrated that these axle difficulties are fundamentally due to concentration of bending stresses in the axle, which in turn are caused or accentuated by the stiffening effect of tightly fitted roller-bearing rolls. Considerable progress has been made in the effort to overcome these troubles but much remains to be done. For obvious reasons the time has passed when locomotive axle failures can be eliminated simply by an increase in size.

In the discussion at the meeting last year the opinion was expressed that cold rolling of axles after machining would be beneficial, and I expressed the belief that this would be a step in the wrong direction. Evidence that has accumulated since that time, while still not conclusive, tends to show that cold rolling is apt to do more harm than good.

Another problem in connection with the use of roller bearings is the relation of roller bearings to wheel failures. This is probably a question for the Wheel Committee to solve and I know that it is not being entirely overlooked. However, now that it has reached the stage where some, if not all, of the wrought-steel-wheel manufacturers have served notice on the railroads that they will no longer accept responsibility for certain wheel defects if they are found on roller-bearing equipment, it is time for the roller-bearing expert, as well as the wheel expert, to consider these facts. Why should wheels under roller-bearing equipment be more susceptible to shelling or thermal checking, or both, than the same kind of wheels under similar equipment fitted with plain bearings? No conclusive answer to this question has yet been found.

#### DRIVING AND TRAILER TIRES

Mr. Ellis: This report covers a summary of the experience through the use of high pressure on various railroads, and, based

on the opinions expressed, they appear to be so diversified that I fear it would be hardly possible to draw a satisfactory conclusion as to whether or not it is advantageous to consider high boiler pressure. Based on my own personal knowledge and experience with so-called higher boiler pressures (that is, above 200 lb.), from a practical standpoint there appears to be as many opinions as there are differences in pressures; and from a theoretical standpoint, taking into account efficiency, expansion and temperatures, there appears to be a definite pressure beyond which the efficiency curve falls off, and, not in the spirit of criticism but rather as a suggestion, I would recommend that the sub-committee handling this report include in their next progress report something definite based on theoretical analysis.

D. J. Sheehan (C. & E. I.): I think that one of the greatest pieces of work that this committee has done in the past year is the development of this tire manual. This subject has been in front of me for the last couple of years and gives me more worry than any other problem on our locomotives.

Ours is a small road and we have had peculiar experiences not common to some larger railroads. Last year, at the 1936 session, I stressed the fact that we were having a lot of shelled trailer tires, but for some unknown reason they were only on one side of the locomotive. Since then I found that other railroads have had the same experience. For example, our trailer-tire troubles have been confined to two classes of locomotives, a class of Mikado locomotives and a class of Pacific-type locomotives. We have two classes of Mikado locomotives in about the same service—that is, high speed, manifest freight service. One class of these Mikado engines give us no trouble, and on the other class we have a failure almost every 27,000 miles. Strange as it

may seem, the engines that give us trouble are equipped with Delta trailer trucks and the other class are not. The question then comes: Is the trailer truck responsible for this condition? I don't know. We do notice one thing in the Delta construction, and that is we have a short trailer dead-ended on the back end of the truck frame. Possibly we don't have enough flexibility in that spring. We are trying a coil spring.

Strange as it may seem, we still are having practically all of our trailer-tire failures on the left side of the locomotive. A year ago I suggested that possibly it was due to weather conditions the previous winter, but last winter was not a severe winter. I suggested that possibly the left side of the engine was riding on harder road bed because it was away from the direct rays of the sun. That does not seem to be the answer, because we had it during the mild winter just past and a lot of it since winter. But, 99 per cent of our trailer-tire failures are still on the left side.

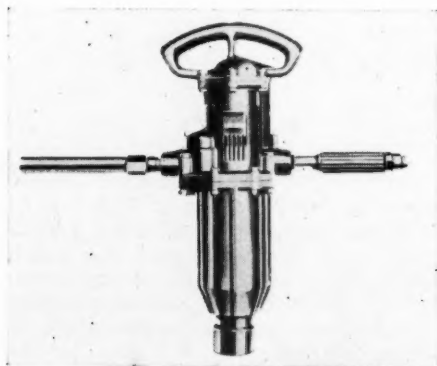
E. C. Hardy (N. Y. C.): I believe the report presents something of great value to inspectors in shops and terminal forces by enabling them to report tire defects uniformly with reference to illustrations contained in the manual. It has been found that the illustrations in the wheel and axle manual are of great assistance and insure proper identification of defects as it is the practice to refer to the proper figure in the Wheel and Axle Manual on all reports of such defective wheels as "Similar to Fig. 20, Wheel and Axle Manual." This same practice could be followed out nicely on the tire manual.

The meeting adjourned—discussion of this report to be continued at Friday's session.

## New Devices . . .

### Reversible Impact Wrench

A reversible impact wrench, size 555, said to have double the power of any impact wrench heretofore available, is being exhibited by Ingersoll-Rand Company, Phillipsburg, N. J. The wrench, which weighs 57½ lb., is recommended for applying and removing nuts and cap screws up to 1¾ in. under normal conditions. It can be used on larger sizes under favorable conditions, and is suitable for practically all nut run-



Ingersoll-Rand Size 555 Reversible  
Impact Wrench

ning which is too heavy for the Ingersoll-Rand size 533 impact wrench. It has a double-grip handle, making the wrench equally convenient for either one-man or two-man operation. One-man operation is

not recommended, however, except when the work is in a convenient position. It is capable of developing about 1,100 impacts per minute.

### Oxweld W-24-R Welding Blowpipe

The Oxweld Railroad Service Company, New York, has recently introduced and is exhibiting an all-purpose welding blowpipe designated as type W-24-R. The range of welding work which can be performed with this blowpipe is very large, being equally suitable for the smallest and largest work performed in railroad shops. It is light in weight, convenient to handle, and the valve stems are accessible for



Oxweld W-24-R Blowpipe Designed for Both  
Large and Small Welding Operations

quick adjustment.

The larger sizes of tips used on the W-24-R blowpipe are made of drawn copper and can be adjusted to any desired angle. The tips are designed with sufficient metal thickness to prevent the heat

of heavy welding operations from affecting the efficient operation of the blowpipe. The life of these tips is, therefore, much longer than those used with other types of blowpipes.

### Columbia Stainless Steel Welding Rod

A recent welding-rod development being exhibited by the Oxweld Railroad Service Company, New York, is the Oxweld No. 28 (18-8) stainless-steel welding rod. The outstanding feature of this rod is its cor-



Stainless-Steel Dining-Car Equipment Is  
Readily Fabricated with Oxweld No. 28  
Columbia-Bearing Stainless-Steel Welding  
Rod

rosion-resistance in the weld metal and adjacent metal, especially at high temperatures. It is furnished in sizes from  $\frac{1}{16}$  in. diameter to  $\frac{1}{4}$  in. diameter and is recommended for use on all railroad equipment and accessories, such as dining-car and lounge-car fittings and other locations where (18-8) stainless steel is used.

## G. E. Railway Type Electric Speedometer

The General Electric Company, Schenectady, N. Y., is exhibiting a speedometer for use on locomotives and cars. It consists of (1) a generator; (2) a transformer-resistor box to compensate for wheel wear; (3) an indicating instrument with a standard scale for recording speeds from zero to 120 m.p.h., and (4) a length of No. 14 twin-conductor tellurium compound rubber-insulated cable complete with a driving disc.

The generator is an alternator with a permanently excited field and the indicator operates in direct proportion to the frequency. Because of this no specially calibrated circuit wires are required. No generator brushes or commutator are used, thus insuring long life and minimum attention. The single generator ball-bearing can be greased at the annual inspection. All leads are totally enclosed. Terminal connections are bolted and easily reached. The generator is driven by a pin in the end of the axle which engages with the slotted disc on the generator shaft. The drive allows liberal misalignment between the generator and the axle without af-



G. E. Railway Type Speedometer Showing the Indicator, the Resistor with a Copper Pin and the Generator for Direct Drive from the Axle

fecting the accuracy or operation of the speedometer. This simple type of drive eliminates the use of belts, pulleys and gears.

The transformer-resistor box is cali-

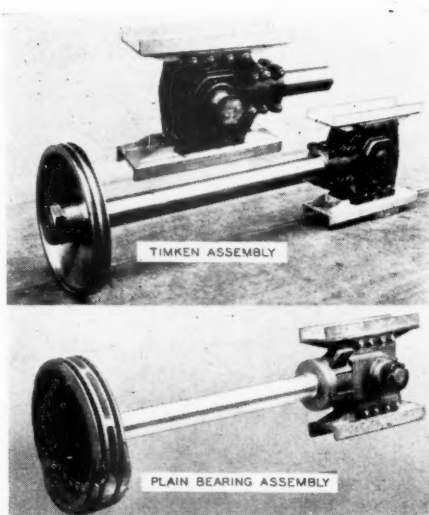
brated for the desired driving-wheel diameter. It contains a manual adjustment for wheel wear.

The indicator, with a black dial with white markings to eliminate the glare, has a pointer which moves over a 270-deg. scale. The construction of this instrument is the result of several years of actual service in the aeronautic field.

To install this equipment it is only necessary to provide a journal-box cover for mounting the generator and install a  $\frac{1}{4}$  in. driving pin in the end of the axle. The transformer-resistor box can be mounted in any desired location in the car or locomotive.

## Light-Weight Revolving And Reciprocating Parts

The Timken Roller Bearing Company, Canton, Ohio, is exhibiting a light-weight piston-and-crosshead assembly which is



Comparison of Timken Light-Weight Crosshead With Standard Keyed-Type Plain-Bearing Assembly

radically different from the usual design of cast-steel crosshead with taper-key fit. The design improvements and the substantial weight reduction made in this Timken crosshead, piston rod and piston were based on a comprehensive series of road-service and laboratory tests. The piston rod with a  $\frac{3}{4}$ -in. wall thickness is keyed by three integral annular grooves to the crosshead consisting of two thick die-forged side plates, as shown in the illustrations. For locomotive applications, the system of annular rings is machined to close tolerances, using gages, and then the piston rod is lapped in the crosshead. By this procedure the desired fit, and stress distribution, in the crosshead assembly are obtained.

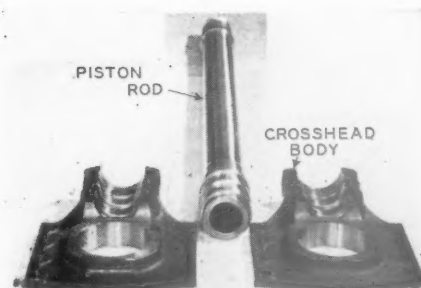
The Timken Company is also exhibiting light-weight main rods, side rods, and crank pins. The eye ends of the rods are deep narrow-width I-sections designed to give considerable rigidity and low bend-

ing stresses. Knuckle-pin joints in side rods and oil and grease holes through the rod eye, which introduce high local stresses and are the cause of many rod failures, have been eliminated. The crank pins are made of thin-wall tapered tubular sections, while the crank-pin bearings are of the usual Timken tapered roller design fitted directly to the crank pins. The driving rods, piston, and crosshead are all die forged; the piston is made from cold-drawn steel while the crank pins are hammer forgings. They are all made from Timken High-Dynamic steel which is a chrome-nickel-molybdenum alloy having the following nominal chemical analysis: carbon, 0.37 per cent; manganese, 0.7 per cent; silicon, 0.27 per cent; chromium, 0.75 per cent; nickel, 1.6 per cent; and molybdenum, 0.25 per cent.

Tests indicate the following comparison of properties between the carbon steel formerly used for locomotive rods and the Timken chrome-nickel-molybdenum steels used in these new forged and heat-treated rods: Elastic limit of 110,000 lb. per sq. in. for the Timken steel, compared with 35,000 lb. per sq. in. for carbon steel; yield point of 115,000, compared with 39,000; ultimate strength of 143,000 lb. per sq. in., compared with 83,000; elongation in 2 in. of 25 per cent for the Timken, compared with 32 per cent for the plain; reduction in area of 55 per cent, compared with 65.9 per cent; Brinell hardness of 275 for the Timken, compared with 136 for the plain steel previously used.

Although the forged main and side rods represent the most striking change from standard practice, substantial weight savings have also been made by machining the piston rod from cold drawn seamless tubing and forging the piston to a lighter section, thus utilizing the higher strength of the alloy steel and its improved properties gained from heat treatment. The same steel is used for these parts as is used in the forged rods.

In the case of one locomotive, weights on the main crank pin have been reduced 350 lb., and 1,030 lb. of unnecessary weight eliminated in the reciprocating parts. This effects a reduction in crank-pin load of

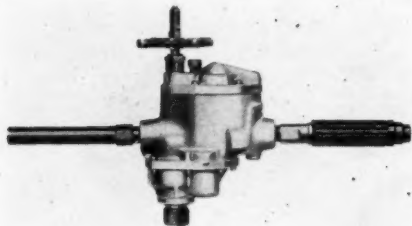


Timken Light-Weight Piston Rod of  $\frac{3}{4}$ -in. Wall Thickness is Keyed by Three Annular Grooves on the End of the Rod to a Crosshead Consisting of Two Die-Forged Side Plates

48,500 lb. when the locomotive is operated at 100 miles an hour. Similarly, a reduction of 66 per cent has been made in overbalance in each driving wheel.

## Non-Reversible Multi-Vane Drills

Ingersoll-Rand Company, Phillipsburg, N. J., is exhibiting its 3SJ and 3SK non-reversible multi-vane drills, which are the largest and most powerful drills in the multi-vane line and are more suitable for heavier classes of drilling, reaming and

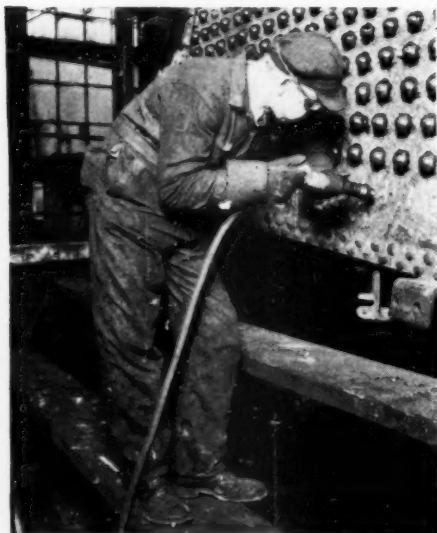


Ingersoll-Rand 3SJ Multi-Vane Drill

tapping than previous drills of this line. Size 3SJ is fitted with a No. 3 Morse taper socket for drilling up to 1 in. Size 3SK, also fitted with a No. 3 Morse taper socket, has an average working speed of 260 r.p.m. and is suitable for drilling up to 1 1/4 in., reaming up to 1 in. and tapping (staybolt) up to 1 1/8 in.

Features of the drills include: Four power vanes, a solid-type hardened-steel rotor located to prevent thrust on end plates, alloy cylinders hardened to resist wear, wide vanes to prevent cramping and to increase life, an automatic oiler, a poppet or plunger-and-poppet throttle valve which is used to eliminate air leakage and permits sensitive speed regulation, an exhaust deflector and muffler, and supporting ball bearings on all rotating parts. The drills are made of aluminum alloy to combine strength and ruggedness with light weight.

The exhibit of the Ingersoll-Rand Company also includes a small light-weight drill of multi-vane design which is suitable for light drilling and reaming on sheet-metal work and for opening



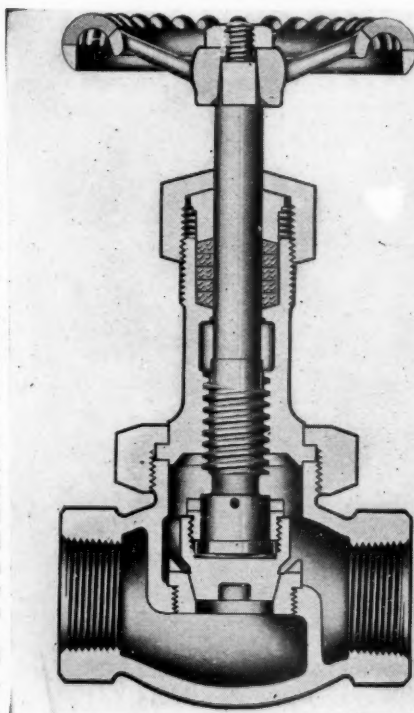
Small Multi-Vane Drill Being Used To Clean Tell-Tale Holes

tell-tale holes in staybolts. It is balanced to run at high speeds with practically no vibration so that small holes can be drilled without breaking the drills.

## A.A.R. Valves, Fittings and Unions

The Crane Company, Chicago, is exhibiting valves, screw fittings, unions, union fittings for pressures of 300 lb. per sq. in. which conform to the specifications and recommended practices adopted by the A. A. R.

*Globe and Angle Valves of the Inside-Screw Type*—These valves are made with either plug-type or ball-type discs. The body is of Crane special brass, while the



The Crane A. A. R. 300-Lb. Inside Screw-Type Globe Valve

bonnet is made of wear-resisting bronze. The union bonnet ring in sizes of 1 1/2 in. and smaller are hexagon, while larger sizes have a round spanner ring. The discs of the 1/4-in., 3/8-in. and 1/2-in. sizes are made of Monel metal spun onto the stem. In all sizes larger than 3/4 in. the disc is made of Crane nickel alloy and is fastened to the stem with a disc stem ring as shown in the illustration. All sizes have an Exelloy body seat ring. The ball-type disc valves are constructed similarly to the plug-type disc valves with the exception that on sizes 3/4 in. and larger, the disc and body seat ring are made of Crane nickel alloy. In the 2 1/2-in. and 3-in. sizes the disc has a bottom pin guide which operates through a bridge in the body seat ring.

*Globe and Angle Valves With Outside Screw and Yoke*—These valves use the same wheel, wheel nut, disc stem ring, disc, body seat ring, union bonnet ring, and body as the inside screw types; only, the stem, bonnet, gland and gland nut are

different. The bonnet is made of cast manganese bronze while the stem is made of 18-8 chrome-nickel alloy steel. In the plug-type disc valves, the disc is made of Crane nickel alloy and the body seat is made of Exelloy. In the ball-type disc valves, both the disc and body seat ring is made of nickel.

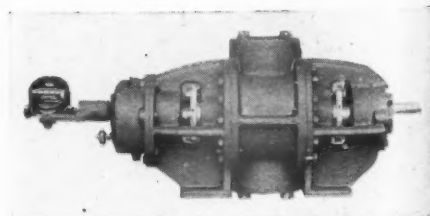
In addition to these valves, the Crane Company is exhibiting A.A.R. malleable-iron fittings, unions, and union fittings for 300 lb. sq. in. steam pressure.

## Cycloidal Water Motor

The Dearborn Chemical Company, Chicago, is exhibiting positive-displacement rotary cycloidal water motors which consist of two specially shaped impellers revolving in opposite directions in a casing whose sides are arcs of circles struck from the center of rotation of each impeller. The impellers are always in contact with each other and also with the casing. The water-motor case and contour of the impellers are accurately machined so that a clearance of a few thousandths of an inch are precisely maintained between the impellers and the case.

The impellers are mounted on parallel shafts that pass through improved stuffing boxes at point where the shafts leave cylinder or casing. The shafts are extended through the stuffing boxes and are supported by four anti-friction bearings of overload capacity. The timing gears, the purpose of which is to synchronize the impellers, are mounted on the ends of the impeller shafts and are accurately machined from steel blanks and heat treated. The gears are totally enclosed and operate in a bath of oil. Both gears and bearings are protected from contact with the water flowing through the motor by stuffing boxes around the impeller shaft. There are no springs, valves, buckets, wheels, liners or internal packing.

A sprocket is mounted on one of the extended impeller shafts with chain drive to a sprocket mounted on the crank shaft of the chemical pump. Sprockets of proper ratio are selected to drive the chemical pump normally at 40 r.p.m. when the water motor is operating at its full capacity. The cycloidal water motor is capable of delivering power far in excess of that required to drive a chemical pump and this power is obtained from the water pres-



The Dearborn Cycloidal Water Pump

sure exerted against the unbalanced projected areas of the impellers. It is furnished in sizes ranging from 3 in. by 3 1/2 in. with a displacement of 3,000 gal. per hr. to 10 in. by 16 in. with a displacement of 98,800 gal. per hr.